XXVIII.]
No. 700.

APRIL 24, 1891.

[PRICE
FOURPENCE.

MAY 5 1891

THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—Subscription per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

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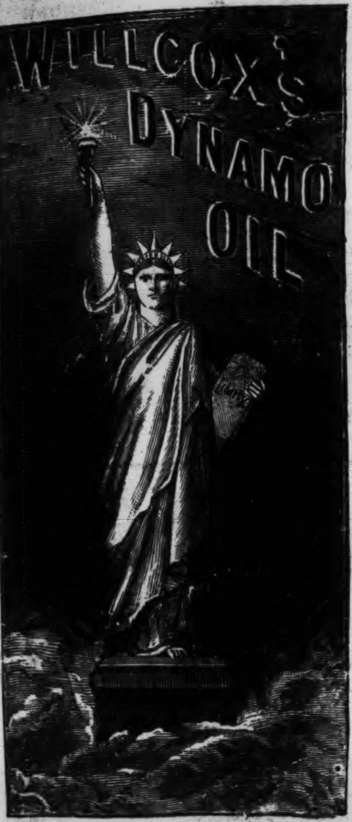

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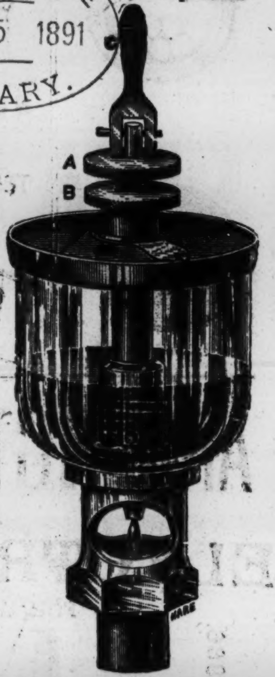

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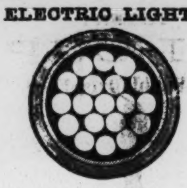

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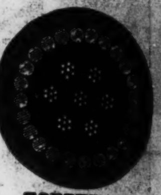

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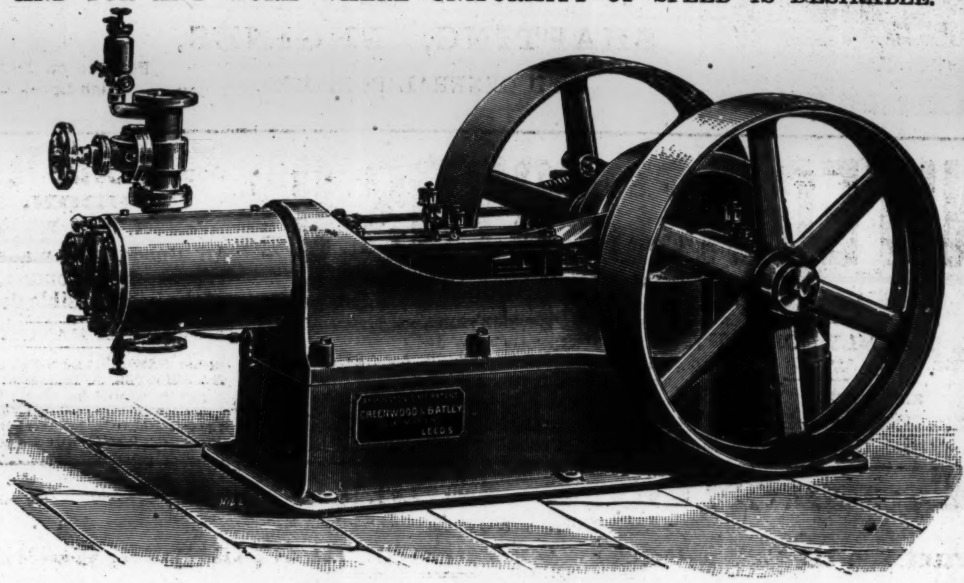

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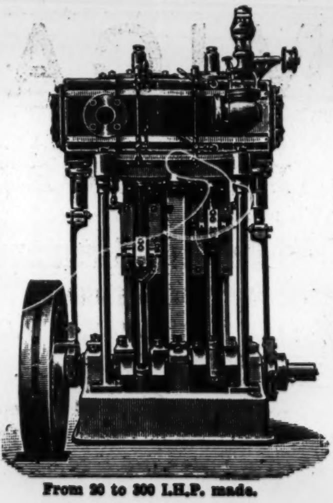

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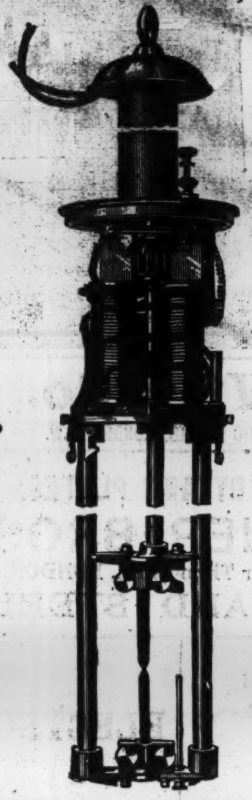

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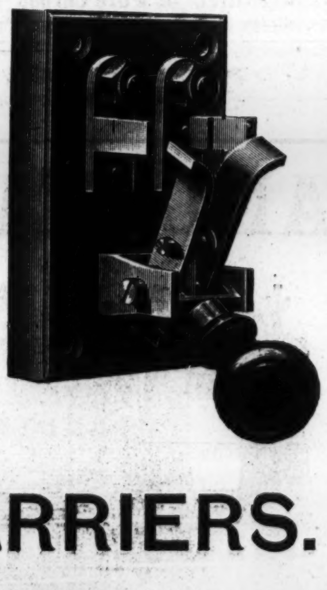

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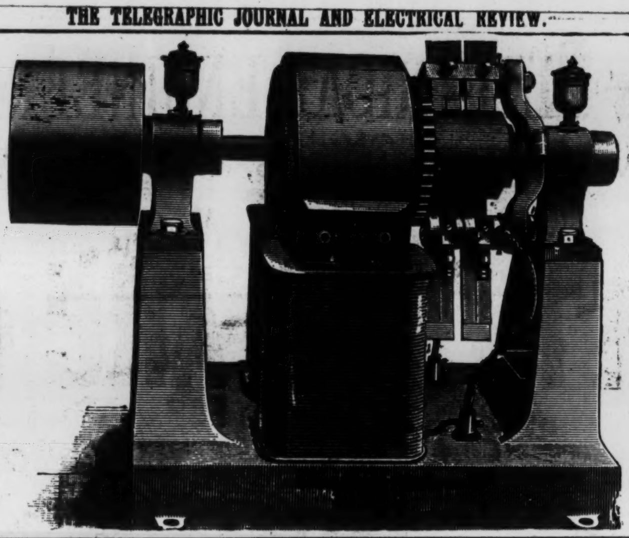

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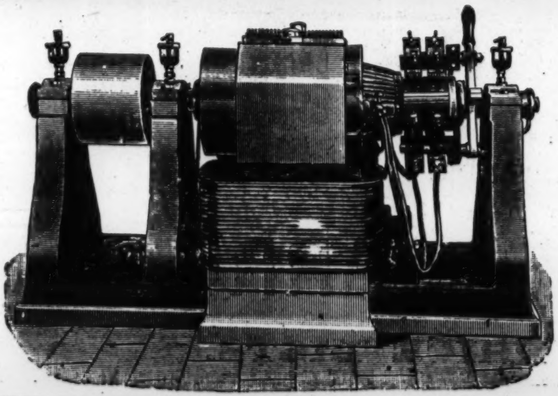

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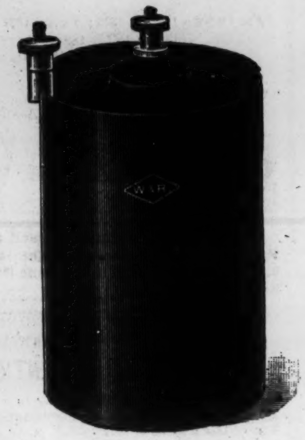

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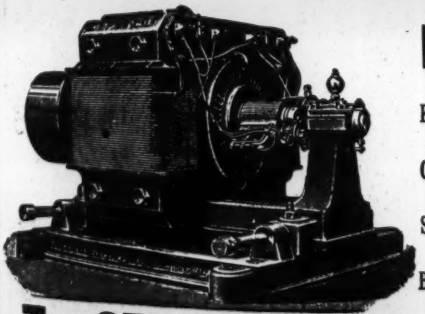

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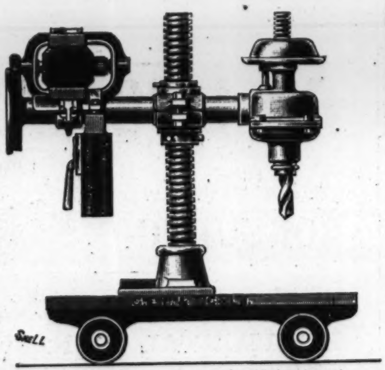

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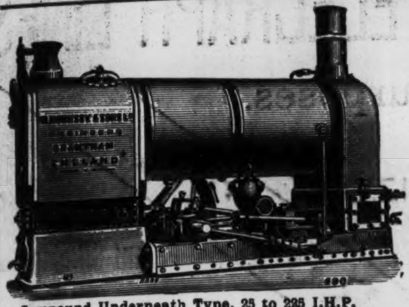

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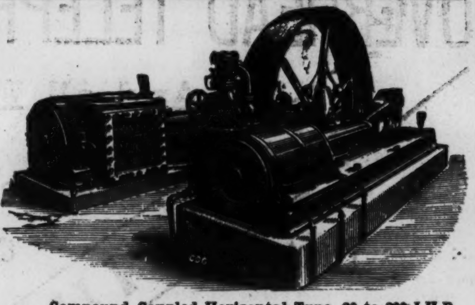

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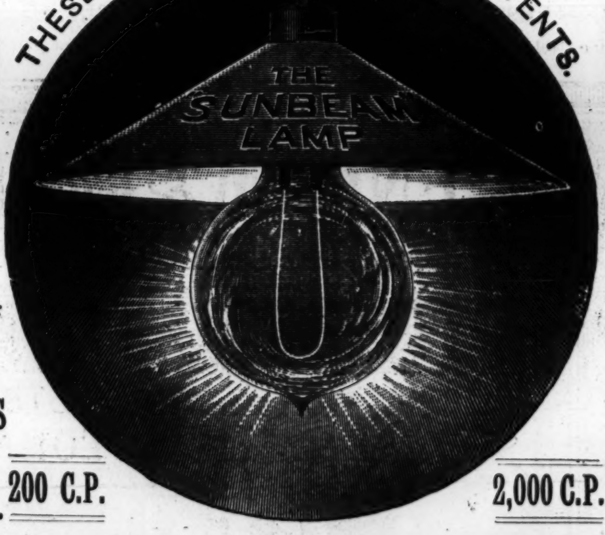

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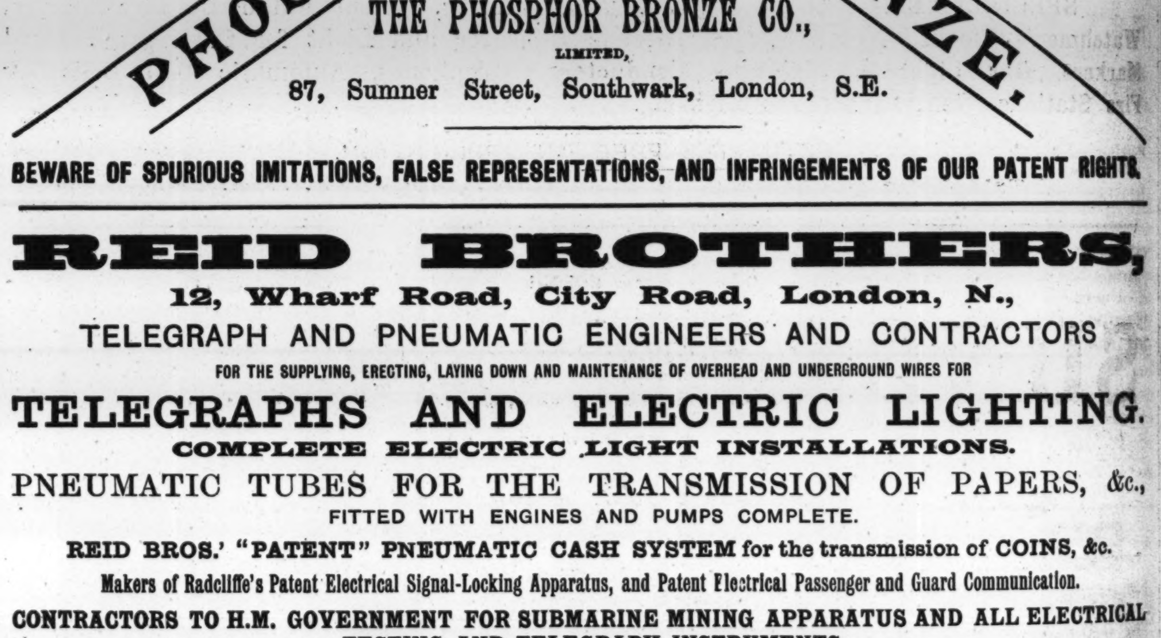
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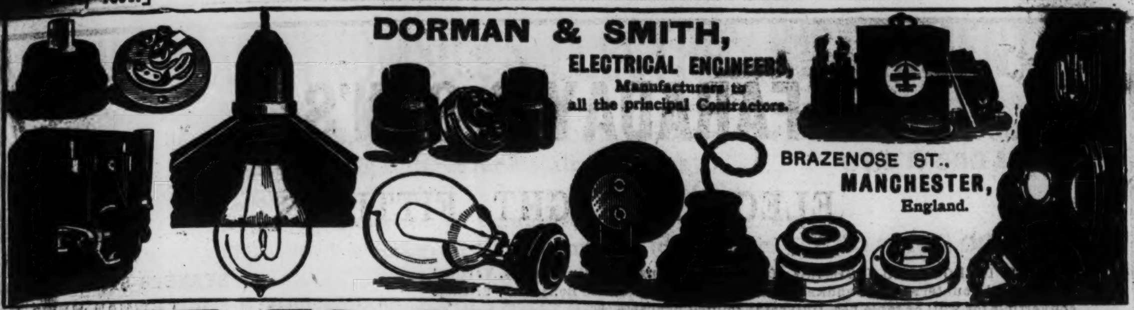

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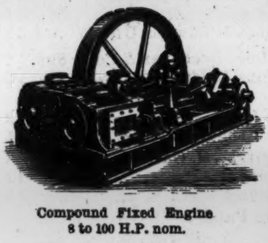

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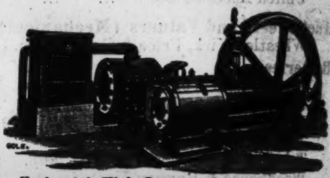

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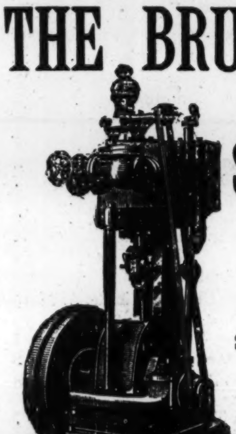

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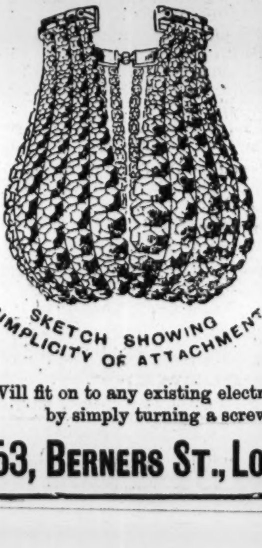

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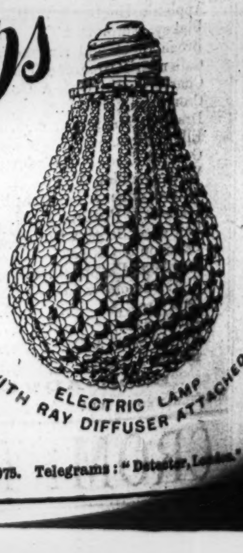

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AND

In the matter of a petition of the said ELECTRICAL ENGINEERING CORPORATION, LIMITED, for the Extension of the aforesaid Letters Patent.

NOTICE IS HEREBY GIVEN that a petition for confirmation of the said Letters Patent has been lodged in the office of Her Majesty's Privy Council, and that any person opposing the said petition will be entitled to be heard before the Judicial Committee of the Privy Council, and that such petition for confirmation, together with the said petition for extension, will be heard by the Judicial Committee of the Privy Council on Wednesday, the 13th day of May, 1891, at half-past ten oclock in the forenoon.

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Secretary.
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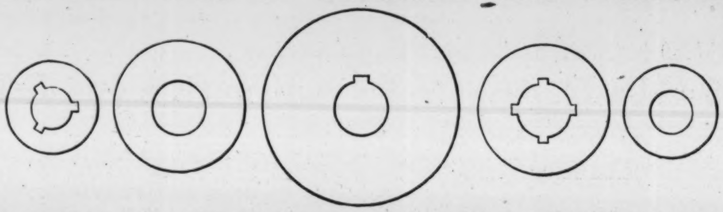

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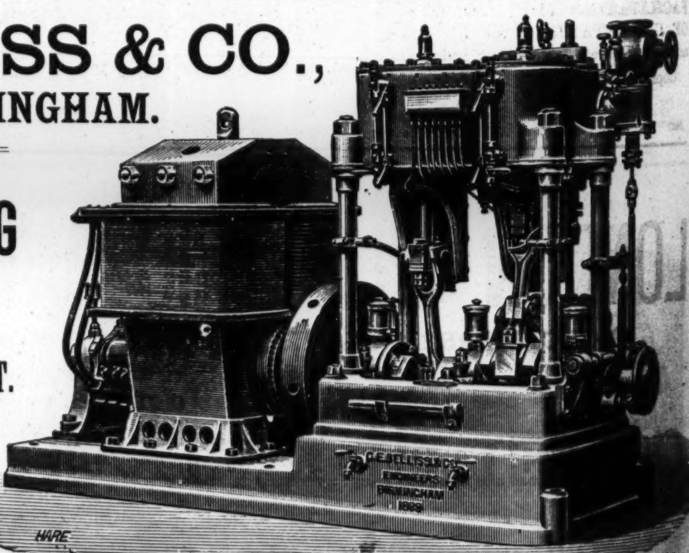

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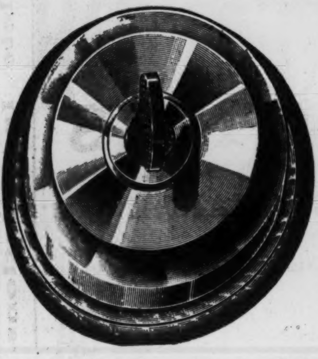

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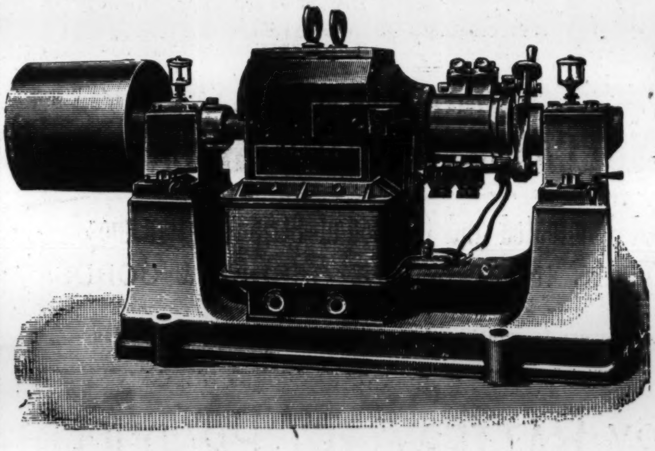

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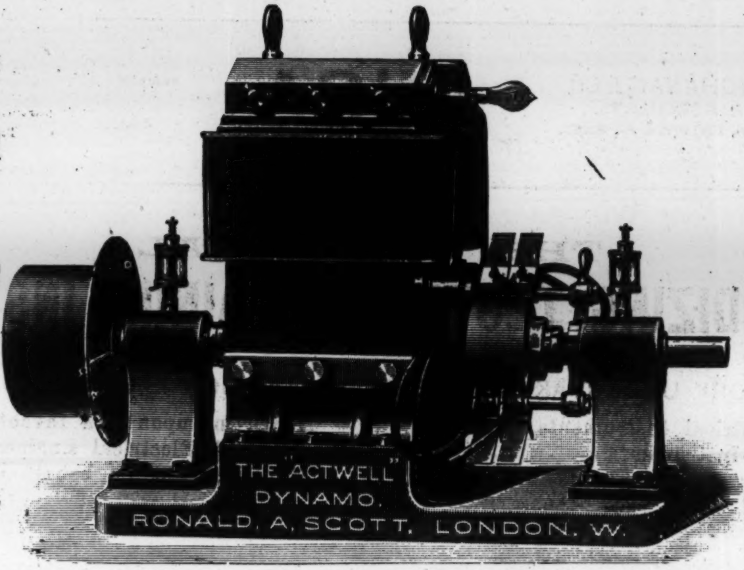
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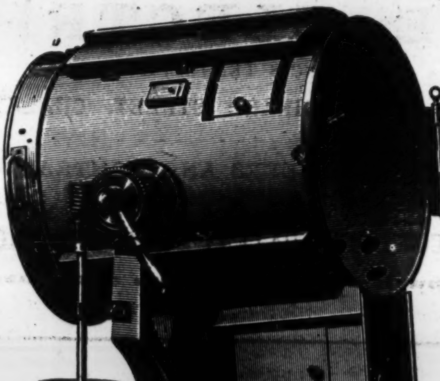

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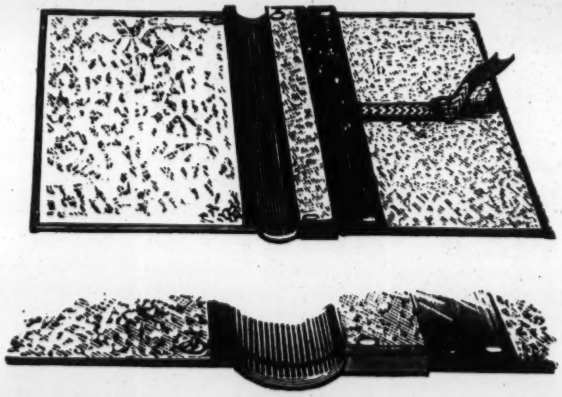

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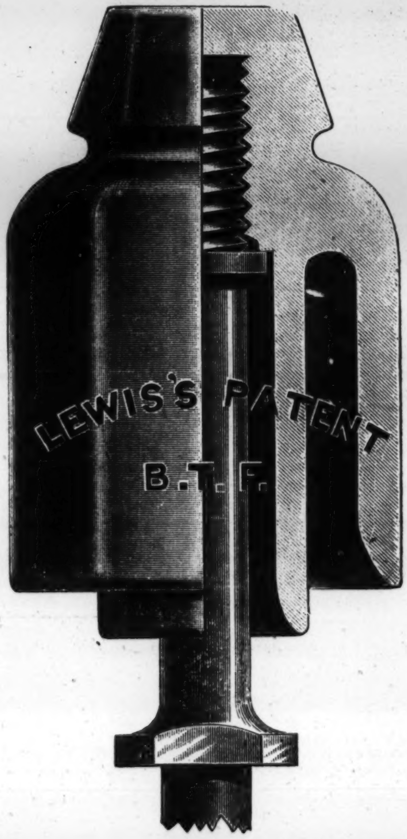
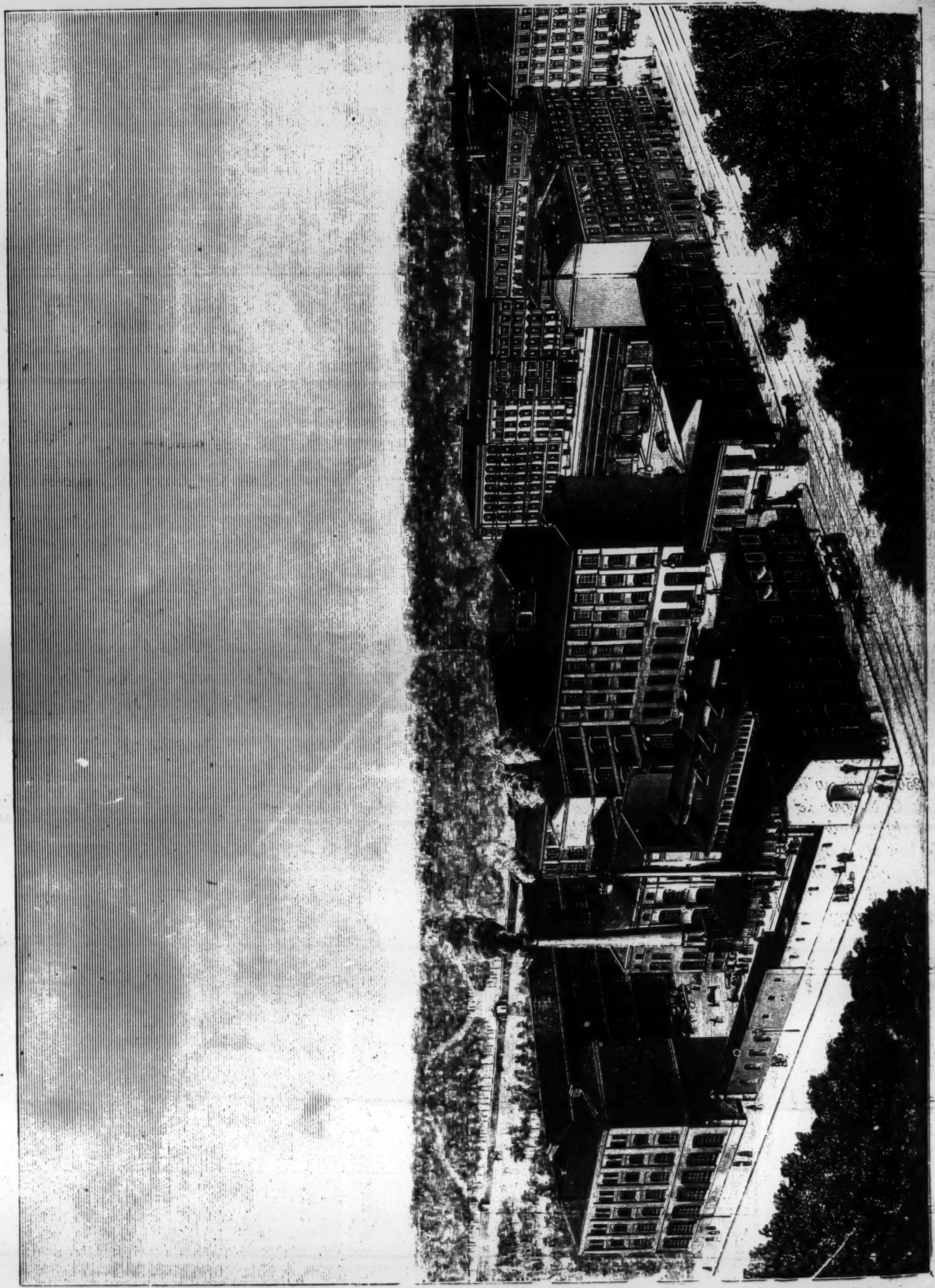


NEW ELECTRIC BELL.

WE omitted to state in the paragraph under the above heading in last week's issue that the bell described therein is covered by letters patent, including the use of a porcelain cover for the gong which can be decorated in any colour or pattern to suit the groundwork of the case. The terminals and metal fittings are also in some cases silver plated to harmonise with the general tone of the decorations—and, indeed, the design of this bell and the materials employed readily lend themselves to quite a large number of really effective variations.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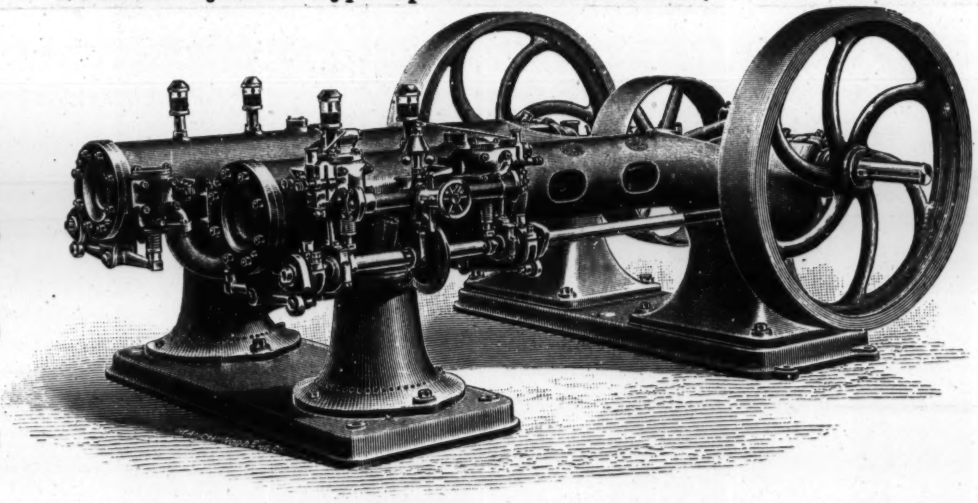

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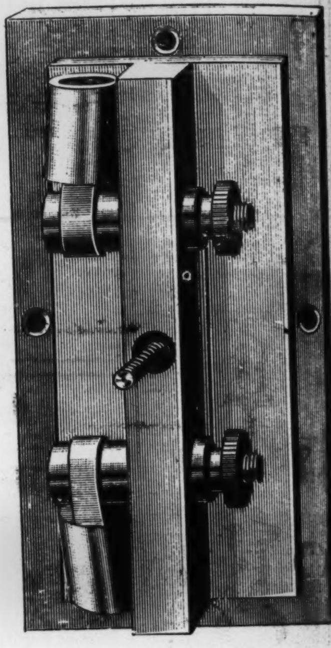

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VOL. XXVIII. APRIL 24, 1891. No. 700

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THE DEBATE ON POSTAL AND TELEGRAPHIC ADMINISTRATION.

THE House of Commons presented a placid appearance last Friday night when, shortly after nine o'clock, Earl Compton introduced his resolution on Post Office administration. The warmth of the debate on the Irish Land Purchase Bill, which had taken place earlier in the evening, and the humour, spleen, and tenacity displayed so largely therein, may have led to the large attendance of members, feeling satisfied, and even surfeited, for that evening, with the amusement, if not instruction, afforded up to that point by the wordy and rancorous collisions of Irish members.

The comparatively large house of upwards of 400 members who voted in the Land Bill discussion was thinned down after dinner to little more than half that number, and the quietness and order prevailing contrasted strongly with the scenes of two hours before. The House, as on many other occasions of a like nature, seemed desirous of being interested, but after-dinner apathy did not wish to be inconvenienced by the rigours of a keen debate on postal or any other administration.

Mr. Gladstone, in a recent speech, advised his hearers never to lose their hold of the purse strings of the nation, as there they controlled the power of the Empire, and similarly the action of Earl Compton in bringing a few pages out of the ledgers of State Control and holding them up to the eyes of Parliament and the country, is not one to be regarded as unnecessary or without its uses and benefits to the community at large.

We have noticed a disposition amongst our contemporaries generally to take sides as it were, in administrative matters, and to guide public opinion into such channels as their sapient paragraphs dictate, condemning in doing so the action of this or that individual, statesman, minister or party. Condemnation when facts are known and where faults or neglect have led to serious results is natural and reasonable enough, and to that we offer no objection, but the system of taking sides is one to be avoided where State administration is under investigation. To those who hold the opinion that no good purpose is answered by the institution of debates on our internal State administration, affecting, as it does, subjects closely allied with the prosperity and success of our national and commercial enterprise, it may be answered that without such discussions little if anything would be known of the real state of progress and expansion of our State-controlled monopolies, and in cases where the march of progress and the attendant expansion were in the wrong direction, and such things have been known, still less would reach the eyes and ears of the deeply interested, though occasionally bewildered, tax-payer.

The present Postmaster-General on sundry occasions, while posing in the style of something akin to a postal Alexander, has boasted of the huge labour army under his control, numbering upwards of one hundred thousand persons. Surely it is as necessary that the country should know as much as possible of the conditions and methods by which so huge a force is controlled and directed as it is undeniably paramount that the nation should have thorough and reliable information as to the position, condition, and efficiency of its gallant army and navy.

Information such as we speak of is seldom to be gleaned from blue-books or Parliamentary returns. In these times, the brain of the country wishes to have something less stereotyped than the matter doled out to it by departmental red-tapists year after year. Mismanagement and incapacity have their place in our civil as well as in our military history, and the tendency of the age is to draw closer to the study of internal economy in all questions affecting our welfare, whether national, commercial, social, or domestic.

It is worth mentioning that Earl Compton during the progress of the evening's business, both before and after his lengthy speech, received a large number of telegrams and communications from the various departments making up the huge system at present under the control of the Secretary's Department of the General Post Office, and it would be unfair and ungenerous to suppose that all these expressions of gratitude and thanks were the outcome of an army of irreconcilables, pledged to nothing but disaffection and revolt, yet we find such uncharitable misconstructions uttered in several quarters where higher views might have been looked for and expressed.

Official sympathy is evidently conspicuous by its absence in the Post Office Departments, all disclaimers to the contrary notwithstanding, and without a friend in Parliament things would indeed seem hopeless for our profit-earning civil servants.

With the debate as carried out in its entirety it is not our intention to deal, but there are points of corroborative interest to ourselves, and, probably, to our readers, and on these matters a few words may be said. Lord Compton dealt at some length on the question of business in the Savings Bank, and the substance of his remarks, as well as the reply of the Postmaster-General thereto, amply confirm the opinion expressed by us in our article on "Post Office Warfare," in our issue of January 16th ult., that an increase of the Savings Bank staff would prove beneficial to the public service. This view has been accepted by the Postmaster-General, and we are not likely to hear again that 531 men have worked 258,000 hours overtime in one year, or roughly speaking, about a quarter of a year's extra duty per man—truly an amazing state of affairs, and representing in a general way that 531 men have had to carry through the work of close upon 700. The only explanation elicited from the Postmaster-General with reference to the Savings Bank was that the staff had been increased, having fallen into diminished numbers pending an enquiry into their status. This may perhaps be understood in the Savings Bank; we do not, we confess, quite follow the Postmaster-General here, and we are sure no one in the House of Commons knew what he meant.

The department, like many others, was, and is still, greatly undermanned, and we see that it has been deemed advisable to censure the supervising officials in the Savings Bank for their want of zeal in rendering themselves objectionable to their colleagues a little lower down in the official scale.

After Sir S. A. Blackwood's full flavoured January eulogies on the "Loyalists," no doubt the gentlemen now censured will regard the former oration in the light of what is vulgarly termed "bunkum," and to use another well worn phrase, will be "dead off" the secretary to the Post Office and all his friendly satellites for the future.

So much for the secretarial eulogium!

Earl Compton, though anxious to bring forward his motion on general and public grounds, held on his way, dealing chiefly with matters affecting the rank and file of the Post Offices services. Nothing came amiss to the noble Earl, who strongly deprecated what is known as "temporary" labour, put in a plea for telegraph messengers, and also asked for further consideration of the case of telegraph clerks.

The noble Earl's speech, and also that of Mr. Lockwood, who followed him, may be regarded as budgets bristling with information never found in official or departmental returns, and the latter gentleman proved conclusively enough that not only in the Savings Bank Department, but also in the Telegraph Department, there was grave reason for saying that the staff was very much undermanned throughout the United Kingdom. For instance, in Dublin, during 1890, the telegraph clerks performed 90,000 hours overtime, representing roundly the labours of about 36 extra clerks; Liverpool, in the same year, 67,000, or about 28 extra clerks; Manchester 57,000, or 23 men; and many other offices are in precisely a similar condition.

At the Central Telegraph Office the staff is being increased by the addition of time expired men from the Royal Engineers, who are enabled, under new regulations, to transfer their services to civil offices on very reasonable and fair terms. Mr. Lockwood objected to underpaid temporary labour, and after the decisions of recent Commissions on "temporary employment" in the Civil Service we are sure the tokens of disapproval expressed in the House on this subject will be re-echoed in the country.

Such speeches as those of Earl Compton and Mr. Lockwood display close and intimate acquaintance with the detail and official routine of Post Office work generally, and theirs has been no casual or haphazard investigation of the subjects on which they have been instrumental in diffusing to the House of Commons and the country more facts in brief compressed sentences than will be gathered from whole chapters of Postal Guides and official regulations.

With Mr. Henniker Heaton, the member largely responsible for the drafting of close upon fifty regulations, improvements and innovations, which he wishes to see applied to our home and colonial services, something akin to disappointment was felt. He came out as the friend and champion of not only the Postmaster-General but of the Post Office and Telegraph Services generally. He conjured for a long time with three names, and reminded many present of the gentleman whose agility and dexterity with the potato, the egg, and the 56 lb. weight find favour with our street corner loungers. The Postmaster-General, the Treasury, and the Post Office—the Treasury, the Post Office, the Postmaster-General—the Post Office, the Postmaster-General, the Treasury.

Never has Henniker Heaton given the Post Office, and above all the Postmaster-General, credit for so much and the Treasury credit for so little. Has he forgotten the unvarnished statement of the Treasury official who recently announced in unmistakable terms that the Treasury had in no way hindered or trammelled the action of the Postmaster-General recently, but had, in fact, given way to every demand made upon it by him?

Towards the end of his speech he dropped the Postmaster-General, however, and found fault with, among other things, the system of counting words in telegrams which abounds in incongruities. As this is matter arranged by the all-powerful Secretary's Department, his remedy may be carried to that spot, and perhaps eventually accepted.

On one important point we heard nothing said, viz., the ridiculously low cost at which press telegrams are accepted. No doubt it paid proprietor-members to remain discreetly silent on such a startling theme.

The Postmaster-General's answer was that no such enquiry as that asked for was necessary; he looked upon it as an attempt at censure. This was sufficient to draw round him in a small House support enough to render the defeat of Earl Compton's resolution a foregone conclusion, but the Postmaster-General admitted inferentially that there might have been dissatisfaction in all branches. Certainly the services had in some respects been undermanned. Steps, he admitted, were being taken to put these and other matters on a more satisfactory footing. Possibly enough, the noble Lord did not regard the matter as any other than a forlorn hope, and even had the House agreed to the resolution it is doubtful in the present uncertain state of political affairs whether a Select Committee would have accepted the labours devolving upon it with any hope of seeing their completion, knowing that a dissolution of Parliament may come when least expected.

The pith of administrative debates, therefore, lies in the fact that they arrest public attention, that they are useful and instructive to those who will take the time and trouble to wade through them, and the party in power knows by such measures of Parliamentary campaigning that their action has to receive the sign-manual of public opinion.

ANOTHER CHAPTER ON ELMORE.

In our correspondence columns we publish another letter from Mr. A. S. Elmore. We must make all allowances for Mr. Elmore. We must not expect that he would have very kindly feelings towards us. Nor must we expect that he would readily bring himself to the point of seeing the force of our contentions in respect to the companies which are notorious under the Elmore name. But after making all allowances we are obliged to express the opinion that Mr. Elmore makes somewhat unreasonable use of the hospitality of our columns. Throughout the discussion which it was our unfortunate duty to inaugurate, we have desired to place every argument for or against the Elmore Companies in the fairest possible light. Mr. Elmore says, that on a former occasion we mis-quoted a patent specification of his, and that he believes that we did so wilfully. If he will only descend from the general to the particular, we shall doubtless find that the fact is as untrue as the motive implied.

Mr. Elmore begins at the beginning by complaining of the title with which we headed his letter. We confess that the journalistic instinct led us into error. His letter, in its main features, was so much more interesting in its copper details than in its zinc details, that the heading must be taken to represent the impression which it formed on an editorial reading. Mr. Elmore desires us to correct certain errors which *we* have made, and thinks we might have avoided doing him the injury of not printing his letter as it was sent us. The MS. of his letter bears evidence of having been press copied. We invite Mr. Elmore to refer to his copy, when he will see that the letter was printed exactly as it was sent to us. Every word which Mr. Elmore says we have altered is a tribute to the perfect accuracy of our staff in reading proofs according to copy. One of the friendly critics of the Elmore concerns referred to the inexperience of Mr. A. S. Elmore and his brother. We must necessarily charitably assume such inexperience to be the cause of his hastening to charge us with errors before referring to his own copy.

We are quite sure that our readers will find no difficulty in appreciating the logic of the position we take in regard to the copper question and the zinc dispute; but we are so desirous that even Mr. Elmore should have no doubt on the subject that we will endeavour to make it plain to him. The Elmore Copper Companies appealed to the public for capital, and recognising, as any competent critic could not help doing, the very unsubstantial basis of those concerns, we expressed our views, and by those published views we stand to-day. In the issue which contained Mr. Watt's letter *re* zinc we published also—quoted from a contemporary—a letter from Mr. Watt *re* copper. We referred editorially to the latter letter, and we remarked that Mr. Watt's views were entitled to consideration. We think so still. To Mr. Watt's letter on zinc we made no reference. Its interest is of a more restricted kind.

For a series of weeks we endeavoured to bring into concrete form the information obtainable on Elmore copper, and Mr. Elmore says that we would prefer to involve them in mystery. Our efforts have always been directed to doing away with the mystery and endeavouring to obtain such facts as may in themselves show that there is no mystery. We wish Mr. Elmore had but realised that one mystery is not to be cleared up by stating another. Particulars, again, would have enabled us to ascertain which are the recent statements characterised by Mr. Elmore as false. Do the restrictions on replying to attacks in the press prevent these being more clearly defined? We have published fully, replies to what Mr. Elmore would doubtless call our "attacks." If Mr. Elmore's instructions are not exceeded by making strong statements of a general nature, and are exceeded by making those statements more specific, the instructions should be altered. Nor do we recognise that Mr. Elmore is in a better position "to judge of their accuracy" than are we. Impartiality is an important aid to sound judgment. We hold an absolutely impartial position in considering anything Elmore. Mr. Elmore is a patentee, a vendor, a shareholder; Mr. Elmore's statements have formed the basis of contracts, of companies, and ventures involving large expenditures. Mr. Elmore has doubtless seen cases where persons have tenaciously adhered to opinions in which their interests are involved long after it has become apparent to the disinterested that those opinions are no longer tenable. Let Mr. Elmore refer to the statements foreshadowed in prospectuses to which his name was attached, and compare them with present prospects. We have extended our columns to him, though we cannot but be surprised at either the effrontery or the self-deception of which his polite letter shows him to be possessed. We cannot expect, and we do not expect, our attitude *re* Elmores to be commended by an Elmore, and we do not intend our attitude to be misrepresented by an Elmore. Our "ideas of honour and fair fight are not to repeatedly kick a man when he is bound hand and foot." Our remarks on Elmores do not relate to "a man." Our remarks apply to men, to organisations, to a series of companies formed on a shallow foundation, involving public peril and professional discredit.

We have made no endeavours to involve Mr. A. S. Elmore in a correspondence on the copper companies. We think he would have been better advised to refrain from commencing one. But we have said, and still think, that the responsible persons in the companies concerned should either give definite information or refrain from public communications altogether. "The end has not yet come," says Mr. Elmore.

The end must have a beginning, and the quotation from our columns which Mr. Elmore gives may yet be found to be accurate. We will not follow Mr. Elmore into Billingsgate, but we will carry Mr. Elmore's concluding remarks to their source. The Elmore companies were specious concoctions. It is useless to utter charms over a wound that needs the knife. We recognised that fact, and in dealing with the Elmore companies we expressed ourselves plainly.

NEW COMBINED SYSTEM OF THE DISTRIBUTION OF CURRENT FOR ELECTRIC RAILWAYS.

[FROM OUR OWN CORRESPONDENT.]

WITH this new system for the distribution of electrical energy, arranged by Carl Zipernowsky, it is intended to supply an extensive district with electric current of suitable dimensions in an economical manner, whether this energy is to be conveyed by means of main conductive cables from central stations, along which the consumption of current is effected by consumers of all kinds, especially for the transmission of power, as for electric railways, &c. Or it may be effected by means of a suitable conductive net with special feeders over an entire district whether for electric lighting, for the transfer of power, or for other purposes.

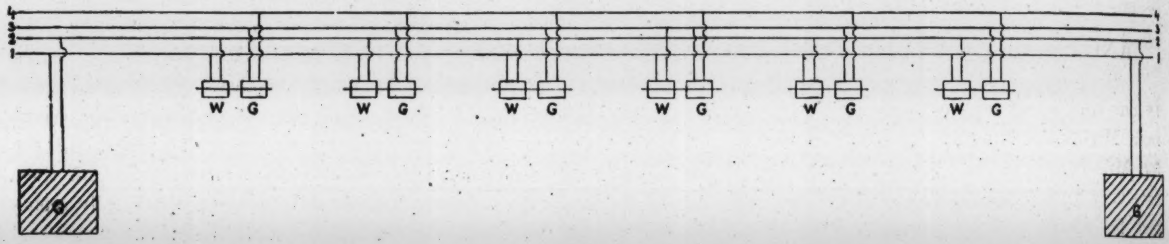

FIG. 1.

An advantageous conduction of energy to a distance involves, as it is well known, the use of high tensions, a demand which from practical reasons can be met only by the alternating current, as according to present experience the production of continuous currents with the required tension of 10,000 volts and upwards, can either not be reached at all or only with great difficulty, and without any guarantee for certain working. With alternating currents, on the contrary, such currents can be used without difficulty. High-tension alternating currents, conveyed to a distance, can be conveniently transformed at the place of consumption into currents of the required dimensions by means of suitable apparatus, so that they may suit all practical demands. This transformation can also be effected, as it is shown in the sequel, if needful, for the transfer of power and the working of electric lines into continuous currents of any desired strength. This may be effected by a current transforming apparatus, consisting of an alternating current motor and a continuous current dynamo. This apparatus may, as a secondary generator, feed a net with a continuous current. The alternating current is, indeed, quite as suitable for motor purposes as the continuous current for the same useful effect. Still, continuous current motors, on starting loaded, have some advantages, especially over synchronous alternating current motors, so that for certain purposes, *e.g.*, for working electric railway lines, they have the preference; a fact which is especially kept in view in the new combined system. It is therefore especially desirable to have a continuous current at command at the places of consumption.

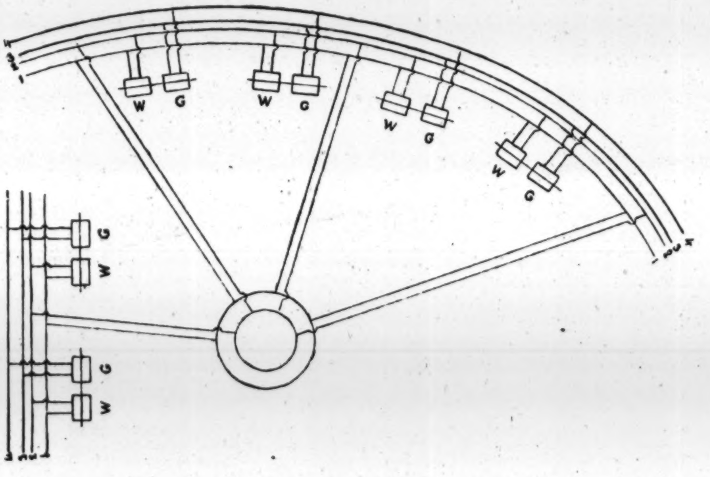

FIG. 2.

The new system of the distribution of energy employs therefore both kinds of electric current, that is alternating current for the conduction to a distance of the energy produced, and continuous current at the points of consumption. The system in its general features can be understood from the figures 1 and 2, whilst the figures 3—5 represent the special development of the transformation apparatus which is brought into play.

The construction of the system is such that a high tension alternating current is produced by alternating current generators or centrals, C, supplied into a primary current lead 1, 2 (fig. 1.) or into a conductive net by means of feeders (fig. 2). Along with this primary cable or net there is arranged a common secondary lead (3, 4, fig. 1 or 2) which is supplied from the primary lead by the intervention of transformation apparatus, W, G, placed at suitable points and which carries a continuous current. These conversion apparatus, W, G, branch off with or without the intermediate introduction of alternating current transformers, T, fig. 3, parallel to and on both sides from the primary or the secondary leads, or are introduced severally. They consist essentially of the combination of an alternating current motor, W, or a continuous current dynamo, G, which are both connected mechanically. The alternating current motor can be movably connected to the alternating current with its keeper, A. The regulation of the whole system takes place by keeping the continuous current by known means at a continuous or nearly continuous tension.

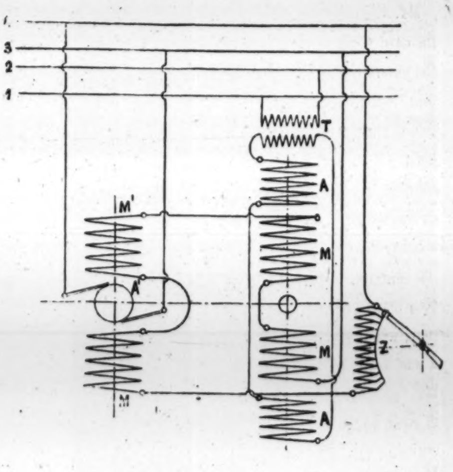

FIG. 3.

The conversion apparatus are shown in Figs. 3—5, in several possible manners by the introduction of the windings of the magnets and the armatures, M, M′ M″, and A, A′. The continuous current dynamo, I, mechanically connected with its alternating current motor, W, has to fulfil two functions. In the first place at the commencement of working it has to start the alternating current motor, which after reaching the proper number of rotations is inserted in the alternating current conductor.

Secondly, this dynamo, after the introduction of the alternating current motor has to serve for the production of the continuous current, and when it is propelled by the motor, to supply the continuous conduction, 3, 4, with current. The continuous current dynamo, G, is fed only at the commencement of the working, but its magnets and the winding, M, of the motor, W, are generally fed from the continuous current lead, 3, 4.

The current necessary for starting the transforming apparatus is always at disposal in the continuous current lead, since such converters are also placed in the alternating current centrals. This can be supported by other known auxiliary appliances, such as current storage apparatus. Either the entire energy conveyed to the alternating current motor can be used for the production of continuous current for the secondary circuit, or a part of it may be taken away at the motor shaft in the form of mechanical work, and can be used for exciting the magnet windings of the apparatus.

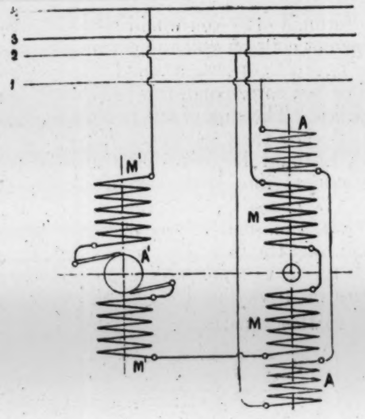

FIG. 4.

The starting of the current transformer, W G, and the exchange of the functions of the motor, W, and the dynamo, G, ensues spontaneously as follows:—the current in the dynamo, G, decreases in the same degree as the motor runs with increasing speed, and becomes = 0 when it reaches the necessary number of rotations, and then, on the introduction of the alternating current lead, flows in the opposite direction, and is fed back into the continuous current lead.

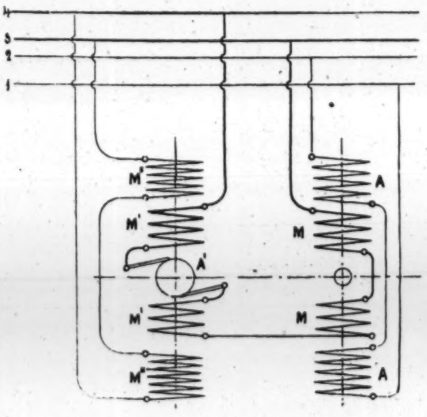

FIG. 5.

If the dynamo, G, is inserted in the continuous current circuit, it propels the alternating current motor, W, and brings it to the required number of rotations. The electromotive force of the dynamo is then less than that of the continuous current secondary circuit, so that the dynamo receives current from the lead. If the alternating current motor, as its speed increases, is inserted in the alternating current lead, its electromotive force rises, and whilst at the same time (either by self-acting mechanical regulation of the excitement of the magnets, centrifugal regulator, &c., or by hand), the counter electromotive force of the dynamo becomes higher than that of the continuous current lead, both these apparatus exchange their functions. The motor, W, undertakes now the propulsion of the dynamo, the current in the latter falls with the changed magnetic excitation or the increasing electromotive force, and the secondary circuit receives current from the dynamo, G, according to its requirement.

The dynamo employed may have either a bye-circuit, or a compound, or a series winding. In fig. 3 the magnet coils, M M', are placed in series beneath each other in common with the help of an additional, or regulation resistance, Z, and are made to branch off from the continuous circuit, as is the dynamo armature, A', separately.

In fig. 4, on the contrary, all the windings, with the exception of the armature, A, of the motor, W, fed by the alternating current, all the windings of the magnets and of the continuous current drum, M, M', A', are connected together beneath each other in series and communicate by a pair of wires with the continuous current lead in a parallel arrangement. The introduction, fig. 5, shows this last case, but with the addition that a second weaker winding, M'', is laid round the dynamo magnets. This winding is fed separately from the continuous current lead so as to influence the magnetisation of the fields reciprocally in the whole apparatus after the manner of a compound winding. Besides the one shown as an instance, there are other methods of arrangement with regulating resistances which secure the mutual relations of the windings of the transformation apparatus.

By this arrangement of leads with a primary alternating current—and a secondary continuous current not supplied from the alternating current producers C, or from the current transformers, W G—there is constituted a system for the distribution of current which unites in itself the well-known advantages and economical features of an alternating current of high tension with those favourable points of the continuous current which are specially required for supplying extended districts, whether for lighting or for the transfer and distribution of power, and furnish satisfactory results, especially for making railways, where the demand made is heavy.

This system of distributing current, which will probably reach practical application in a very short time, will be found especially advantageous in cases where an electric line carried to great distances is to be worked in connection with an existing continuous current installation.

ON ROTARY CURRENTS AND THE ART OF MEASURING THEM.

BY HANS GÖRGES.

(Concluded from page 508.)

We will now consider the two cases which have been mentioned above and are illustrated by figs. 4 and 5, in which the useful work is performed either only by the three currents, I_1, I_2, I_3, or else only by three currents, I_a, I_b, I_c. In the first case the branches I_a, I_b, I_c only play the part of feeders. As a third case, we will consider the relations occurring in an ordinary two-wire system distributing either continuous or alternating current.

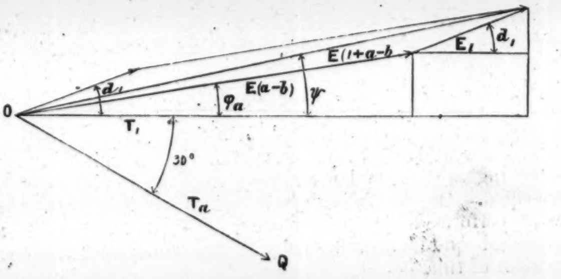

FIG. 9.

We will assume that in every case the pressure at the terminals of the energy consuming device and the useful work consumed are the same, and likewise that the same total amount of copper has been put into the conductors, equal distances from generating to consuming station being understood. We then ask, which is the loss by heat generated in the conductors in the three cases?

In the first case the useful work is $3 \cdot I_1 \cdot E_1$, and making the resistance of one main R_a the heat generated in the conductors is

$$3\,(I_a^2 \cdot R_a) = 3 \cdot (1{,}732^2 \cdot I_1^2\,R_a) = 9 \cdot I_1^2\,R_a.$$

In the second case the useful work is $3\,(I_a\,E_a)$, and the heat generated in the conductors

$$3\,(I_a^2 \cdot R_a).$$

In the third case the resistance of each main is smaller, since there are only two of them, namely

$$R = \frac{2}{3}\,R_a.$$

Therefore assuming the same useful work to be consumed as in the first and second case, namely, $3\ I \cdot E$, the heat generated in the conductors will be

$$2 \cdot \left[\frac{2}{3}\,R_a \cdot (3 \cdot I)^2\right] = 12 \cdot I^2 \cdot R_a.$$

Consequently the losses in heat generated in the conductors in the three cases are as

$$9 : 3 : 12 = 3 : 1 : 4.$$

Thus if you assume equal useful pressures the drop of pressure is three times as great when the first mode of distribution is adopted than when the second is adopted, and the ordinary two-wire current will work with even greater loss. In the first case the currents in the mains are larger than the useful currents, but the pressures between the terminals—deducting the loss of pressure—are equal to the useful pressures, in the second case the reverse takes place, as is easily seen in the diagrams. The ratio between the two is always

$$1 : 2 \cos 30^\circ = 1 : 1{,}732,$$

a number which may be considered as specially characteristic of rotary current with three terminals.

Exactly in the same way when rotary currents with n mains are employed, assuming as before equal load in all branches, we obtain

$$\left.\begin{aligned} I_1 &= \frac{I_a}{2 \sin \frac{180}{n}} \\ A_a + A_1 &= I_a \cdot E_{(a+1-b)} \cdot \frac{\cos \psi}{2 \sin \frac{180^\circ}{n}} \end{aligned}\right\} \quad (9)$$

in which ψ is again meant to express the difference of phase between I_1 and $E_{(a+1-b)}$.

Further it follows therefrom that

$$\frac{A' - A''}{A_a + A_1} = 4 \sin^2 \frac{180^\circ}{n} \quad (10)$$

and

$$A = n\,(A_a + A_1) = \frac{n}{4 \sin^2 \frac{180^\circ}{n}} \cdot (A' - A'') \quad (11)$$

According to this formula the factor by which the expression $(A' - A'')$ must be multiplied to obtain the total work in the system is for

$$n = 3, 4, 6, \ldots$$
$$\text{factor} = 1, 2, 6, \ldots$$

Till now we have always assumed that the magnitudes vary according to the sine law and that the loads in all branches are equal. In the following we will investigate how the work performed by rotary current of three mains can be measured quite unconditionally. The total work in one element of time is

$$a \cdot dt = (i_a \cdot e_a + i_b \cdot e_b + i_c \cdot e_c + i_1 \cdot e_1 + i_2 \cdot e_2 + i_3 \cdot e_3)\,dt. \quad (12)$$

in which the small letters stand for the variable magnitudes. Further the relations exist

$$\left.\begin{aligned} i_a &= i_1 - i_3 \\ i_b &= i_2 - i_1 \\ i_c &= i_3 - i_2 \end{aligned}\right\} \quad (13)$$

$$i_a + i_b + i_c = 0 \quad (14)$$

as is easily seen in the diagram, fig. 3, by paying attention to the signs. Finally, we gather from the same diagram that

$$e_1 + e_2 + e_3 = 0 \quad (15)$$

because these pressures all occur within the closed line $D_1\,D_2\,D_3\,D_1$.

If you wanted to measure the work—the value of which is given by the following expression—

$$A = \frac{1}{T} \int_0^T a\,dt \quad (16)$$

according to formula (12) you would have to take six wattmeters the current coils of which were inserted in each of the six branches I_a, I_b, I_c, I_1, I_2, I_3, and the pressure coils of which were inserted correspondingly between the end of each of these branches. The sum of their readings would then be the work A. Besides the great inconvenience of this mode of proceeding, it would be impossible in many cases to get the currents $I_1\,I_2\,I_3$ into your current coils or to measure them at all. The necessity, therefore, ensues, to transform the expression (12) in such a way that it only contains the currents $I_a\,I_b\,I_c$ and the pressures between P_1 and P_2, P_2 and P_3, and P_3 and P_1, the values of which can easily be measured. These pressures we have called E_α, E_β, E_γ, and obtain therefore the three further equations:—

$$\left.\begin{aligned} e_a + e_1 - e_b &= e_\alpha \\ e_b + e_2 - e_c &= e_\beta \\ e_c + e_3 - e_a &= e_\gamma \end{aligned}\right\} \quad (17)$$

We now imagine the current I_a combined in the wattmeter with the pressures E_α and E_β and form the equation:

$$\left.\begin{aligned} i_a\,(e_\alpha - e_\gamma) &= i_a\,(2\,e_a - e_b - e_c + e_1 - e_3) \\ i_b\,(e_\beta - e_\alpha) &= i_b\,(2\,e_b - e_c - e_a + e_2 - e_1) \\ i_c\,(e_\gamma - e_\beta) &= i_c\,(2\,e_c - e_a - e_b + e_3 - e_2) \end{aligned}\right\} \quad (18)$$

By adding up and slightly transforming the right side we obtain:

$$\Sigma = i_a\,(e_\alpha - e_\gamma) + i_b\,(e_\beta - e_\alpha) + i_c\,(e_\gamma - e_\beta)$$

$$\begin{aligned} \Sigma = 3\,(i_a \cdot e_a + i_b \cdot e_b + i_c \cdot e_c) &+ i_a\,(-e_a - e_b - e_c + e_1 - e_3) \\ &+ i_b\,(-e_b - e_c - e_a + e_2 - e_1) \\ &+ i_c\,(-e_c - e_a - e_b + e_3 - e_2) \end{aligned}$$

In which substitute for the currents i_a, i_b, i_c, the currents i_1, i_2, i_3, according to equation (13), and you will obtain:

$$\begin{aligned} \Sigma &= 3\,(i_a \cdot e_a + i_b \cdot e_b + i_c \cdot e_c) + \\ &+ i_1\,(-e_a - e_b - e_c + e_1 - e_3) - i_3\,(-e_a - e_b - e_c + e_1 - e_3) \\ &+ i_2\,(-e_b - e_c - e_a + e_2 - e_1) - i_1\,(-e_b - e_c - e_a + e_2 - e_1) \\ &+ i_3\,(-e_c - e_a - e_b + e_3 - e_2) - i_2\,(-e_c - e_a - e_b + e_3 - e_2) \end{aligned}$$

and therefrom by a slight transformation,

$$\begin{aligned} \Sigma = 3\,(i_a \cdot e_a + i_b \cdot e_b + i_c \cdot e_c) &+ 3\,(i_1 \cdot e_1 + i_2 \cdot e_2 + i_3 \cdot e_3) \\ &- (i_1 + i_2 + i_3)\,(e_1 + e_2 + e_3) \end{aligned}$$

and therefrom, finally, with regard to (15)

$$\Sigma = 3\,(i_a \cdot e_a + i_b \cdot e_b + i_c \cdot e_c) + 3\,(i_1 \cdot e_1 + i_2 \cdot e_2 + i_3 \cdot e_3). \quad (19)$$

Consequently,

$$\left.\begin{aligned} a\,dt &= \frac{1}{3} \cdot \Sigma\,dt \\ a\,dt &= \frac{1}{3}\left[i_a\,(e_\alpha - e_\gamma) + i_b\,(e_\beta - e_\alpha) + i_c\,(e_\gamma - e_\beta)\right] dt. \end{aligned}\right\} \quad (20)$$

This equation offers a more convenient method of measuring the work performed by the rotary current. *You want only three wattmeters, the current coils of which are inserted in each one of the currents* I_a, I_b, I_c, *while one end of their pressure coil is connected to the corresponding terminal,* P, *and the other end first to the second and then to the third terminal.* In this way six works are found, three of which, according to our rule about the positive direction, must be considered as negative. Therefore the simple addition of the works so found—provided that the dynamometer every time turns in the same sense—gives the total amount of the work performed multiplied by three.

It is worth mentioning that in this deduction no assumption whatever has been made as to the shape of the single alternating currents that make up the rotary current. This method is, therefore, unconditionally correct. Nevertheless, it is far from simple and it will therefore be found well worth while in practice to investigate whether the loads in the branches, I_a, I_b, I_c, and at the same time in the branches, I_1, I_2, I_3, are not equal, *i.e.*, whether

$$i_a\,(e_\alpha - e_\gamma) = i_b\,(e_\beta - e_\alpha) = i_c\,(e_\gamma - e_\beta) \quad (21)$$

If this be the case equation (20) takes the following simple form :

$$a\,d\,t = i_a\,(e_\alpha - e_\gamma)\,d\,t \qquad (22)$$

which allows of the employment of only one wattmeter, and of only one switching.

In the experiments carried on at the works of Messrs. Siemens and Halske this condition could be considered as fulfilled, since the differences found amounted to no more than an admissibly small percentage. The simplified method was therefore exclusively applied. For this purpose wattmeters are at present being wound in the shops of that firm, the pressure coils of which contain two windings. Such an instrument will measure directly the work expressed by (22), if the one winding is excited by the pressure, e_α, and the other by the pressure, e_γ; and the same end of both windings is connected to the pole, A. Thus you can obtain the total work with one single reading.

JOEL'S PATENT SWITCHES FOR ELECTRIC LIGHT.

THESE switches are used for controlling groups of electric light lamps in departments, *i.e.*, main switches, and are made in various sizes by Messrs. Henry F. Joel & Co.

The base is glazed porcelain, and fireproof ; the contact bar is made of hard rolled brass, and is slotted and cut into separate and springy combs at each end. Each tooth of the metal combs presses independently on the terminal block, the object being to make as many points of contact as possible. These contact bars pass under sparking shields fixed on the terminal blocks. The switch, shown in fig. 1, is a double break spring off switch ; the spring action is obtained by two flat steel springs pressing upon an elongated stem in the centre, flat one way when the springs are off, and pointed the other way, and thereby distending the springs when the contacts are on. The switch bar is put "on" or "off" by means of a detachable key, fitting on to a square end on the centre stem. The whole of the switch action and terminals is enclosed in a brass cover with a bevelled plate glass front. The advantages of this switch are : Good electrical contact, double break spring action, protection from dust and from mischievous interference, and whilst only the manager of the department has the control, the glass front allows anyone to see that the switch is in order, and whether "on" or "off."

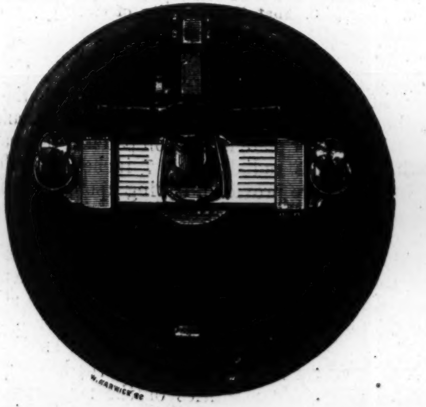

FIG. 1.

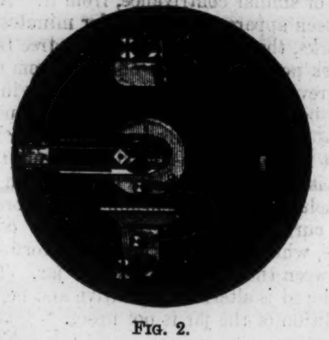

FIG. 2.

Another form of this switch, fig. 2, is single break only on one side, and has a long fuse on the other side. A ridge of insulating and fireproof material is placed between the centre of the switch and terminal block, and the fuse wire has to go round this ridge ; this arrangement provides a long sparking space between the two metals.

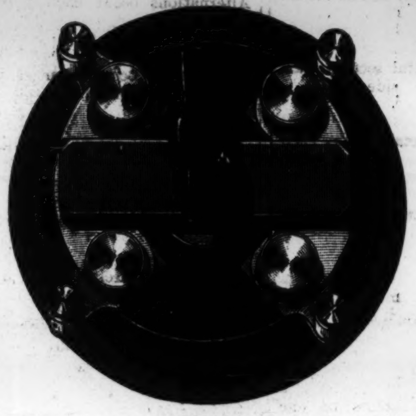

FIG. 3.

The switch shown in fig. 3 has a four-way action, and is of the same type as the preceding with detachable handle. This switch is used for changing the current to the lamps, say, from a dynamo installation alternatively with the current from a supply company's mains, and separate clamping screws are provided on the ends of the curved arms used for bridging across the terminals, so that when the changes are not often required the contacts can be clamped together.

Messrs. Joel & Co. have made many hundreds of these switches during the last few years, and have proved them to be very reliable and most useful. They are the only switches made specially for use in departments of warehouses with glass covers and detachable handles, and are exceedingly neat and workmanlike.

WIMSHURST'S ALTERNATING INFLUENCE MACHINE.*

AMONG the various machines which have been constructed for the generation of statical, or so-called frictional electricity, none can be compared with that of Mr. James Wimshurst, of the consultative staff of the Board of Trade, London, either for simplicity, reliability, or efficiency. These merits of the Wimshurst influence machine are known to a very wide circle of electricians and physicists ; consequently the news that the inventor has brought out another, having very curious and unlooked-for qualities, will be received with interest and expectation in many laboratories, schools, and homes, and will secure for it an attentive reception, which its remarkable features fully justify.

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* *Engineering.*

A remarkable feature of the new machine is that while it gives an abundance of sparks, it is impossible to charge a Leyden jar, or similar contrivance, from it. After the electricity has been apparently flowing for minutes into the jar in rapid sparks, the latter is found to be free from all charge. Neither spark nor shock can be obtained from it, and delicate tests fail to reveal the presence of electricity in it. It is as if one had been pumping water into a bucket with no bottom; the stream is plainly to be seen, but nothing accumulates. It is, however, easy to demonstrate the integrity of the jar, and its capacity to hold a charge when filled from an ordinary machine. The conclusion is therefore forced upon us that the current of sparks is really the oscillation of a small charge, which flows backwards and forwards with great rapidity between the machine and the jar. The electricity that is developed is alternately positive and negativé, and the normal condition of the jar is not upset.

TABLE SHOWING RESULTS OF COMBINATIONS

Discs.	Four Large Inductors.	Four Small Inductors.	Two Inductors and Rod.
Plain glass and no metal.	Is self-exciting with about 4 revolutions. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting but requires care. Alternations occur each $\frac{3}{4}$ revolution.	Is not self-exciting but requires little assistance. Constant current while not overtaxed; gives large current.
Two metal sectors each side.	Is self-exciting. Alternations occur after each two sectors pass brush.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Constant current.
Four metal sectors each side.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Constant, but gives less current.
Eight metal sectors each side.	Is more freely self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Constant current.
Sixteen metal sectors each side.	Is freely self-exciting with 3 revolutions. Alternations occur each $\frac{3}{4}$ revolution.	Is more freely self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is freely self-exciting. Constant, but gives less current.
Sixteen sectors on one side.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting. Alternations occur each $\frac{3}{4}$ revolution.	Is self-exciting when sectors are next the rod. Is not self-exciting when sectors are next inductors. Constant in either case.

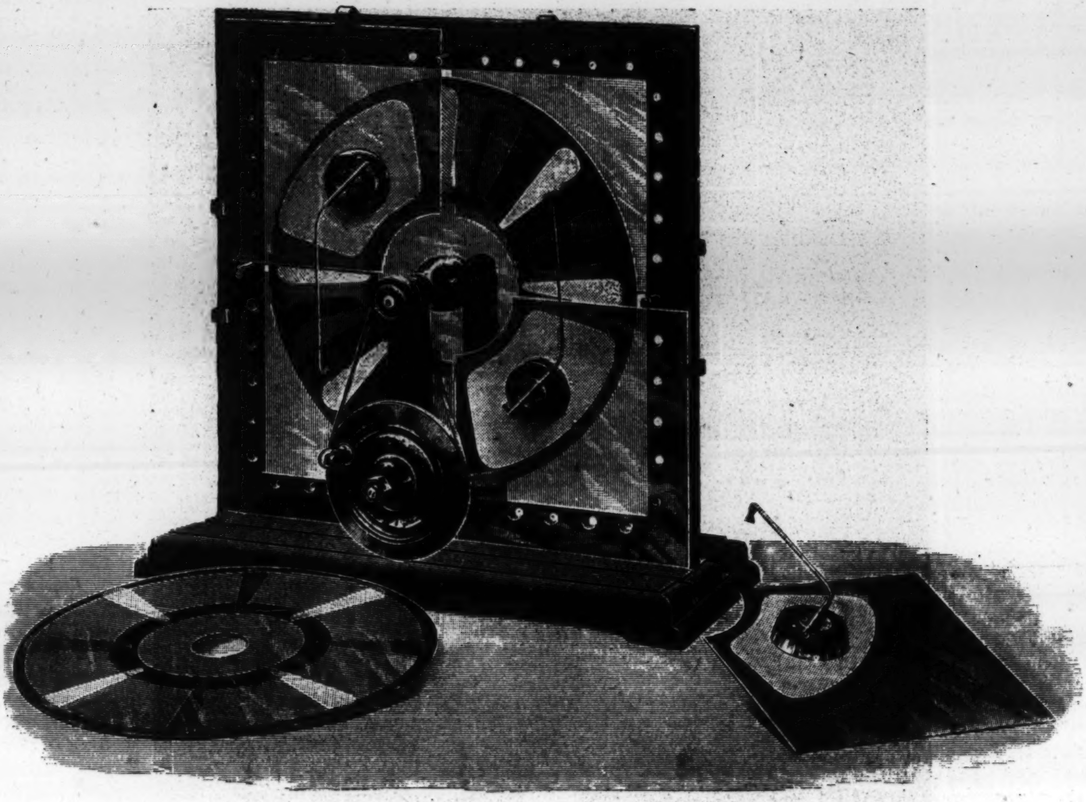
NOTE.—The principal features are: 1. That glass discs with no metal upon them are capable of self-excitement. 2. That the self-excitement increases about proportionally to the increase in the number of sectors. 3. That the quantity of electricity decreases about proportionally to size of sectors, and also their number.

If we investigate the action of the machine more minutely by the aid of an electroscope of an exceedingly delicate construction, we find confirmation of the hypothesis that positive and negative electricity is produced alternately. Commencing to turn the disc exceedingly slowly, say, at the rate of three or four revolutions per minute, the leaves of the electroscope suddenly diverge, being repelled from each other. They remain apart quite steadily until the disc has made rather more than three-quarters of a revolution, when they suddenly approach and cling together, showing that the sign of their charge has changed. They remain thus for an instant, and during another three-quarters of a revolution they again separate, and so on. But if the disc be turned rapidly the leaves are no longer able to respond in this way to the changes of charge. Such light appliances, with their large surfaces exposed to the air, are incapable of rapidly approaching and receding through a considerable distance under the small stresses brought to bear upon them. They consequently take up a mean position between the extreme ends of the range, and show the alternate attractions and repulsions to which they are subject by a quick fluttering or tremor. It is abundantly evident that they are subject to varying stresses, which the retarding effect of the atmosphere will not allow them to completely obey.

The appearance of the machine is clearly shown in the engraving. A central spindle carries a glass disc 16 inches in diameter. This is varnished, and has affixed to it a number of sectors of tinfoil. The sectors measure 4 inches radially, while in breadth they may vary from ¼ inch to 5½ inches. Usually the sectors on one side of the disc are arranged to break joint with those on the other side, but this is not essential. Indeed in many respects the construction of the machine is very elastic, and many modifications are introduced. For instance, the number of tinfoil sectors may vary from 2 to 16 or more, on each side, and as we have said their relative positions on the two surfaces of the discs are not important. The results of different combinations are given in the table. The disc itself is mounted in the centre of, and in the same plane as, a wooden frame 20 inches square. This frame carries four inductors of the shape shown in the detached view; they are 9¾ inches square, with one corner cut away to admit the spindle and boss of the disc. Two of the inductors are mounted on each side of the frame, at opposite diagonal corners; those at the side of the machine nearest the spectator are, say, at the upper left hand and the lower right hand corners. At the opposite side the inductors are at the upper right hand and the lower left hand corners. Upon each inductor plate is a tinfoil patch of the shape shown, measuring 4 inches radially and 7 inches circumferentially. Other inductors are provided, having upon them the smallest tinfoil patch practicable. Cemented over each patch is a wooden disc which on its face carries a bearing in which there rides a bent brass rod, having a plume of fine wires at its end, touching the glass discs at a point 90° remote from the inductor, and opposite one of the inductors at the other side of the plate. The disc is thus touched on both sides in two places. It is driven by a cord from a small handwheel below, and revolves in the direction of the hands of a clock. To further vary the capabilities of the machine a bar of insulating material is made to carry two metal wire plumes at its ends, these having metallic connection with two terminals; this device takes the place of two of the inductors, and by its use a constant flow of electricity may be maintained.

The machine which we illustrate has been constructed with the view of being most readily used for the purpose of demonstration and experiment. It is provided with several discs, having different arrangements of sectors, and all the parts are made interchangeable. By withdrawing the rear bearing the nut on the spindle can be screwed off at once, when half the boss comes away and the disc can be withdrawn and be replaced by another in a few moments. The inductors lie on pegs on the square frame, and are held by light steel clips; provision is made by a number of holes in the frame for the use of inductors of different sizes. To couple one inductor to another, if such an arrangement should be desired, holes are bored in the wooden discs carrying the brush-holders, and into these holders the ends of wires can be inserted, the wires being bent in such a way to join any pair of inductors. The parts of the machine are beautifully finished, and all the ends are attained by the simplest devices.

The method of action of this instrument is not very easy to follow, and indeed no theory has yet been put forward in explanation of the results which flow from it. Probably the members of the Physical Society may be able to make some suggestions that will throw light on the subject.



THE ELECTRIC LIGHTING OF SAINT BRIEUX.

ELECTRIC lighting is slowly but surely gaining ground, and the towns which at first seemed least suited to its development, now enter freely into the movement adopting this mode of illumination, appealing, in order to solve the fresh problems which present themselves in each particular case, to the most improved methods, and the most elegant solutions now known in electrical industry, an industry of great richness and fertility, notwithstanding its youth. The lighting of the town of Saint Brieux supplies us with a typical example, and we think it will be interesting to give a general description of it, for we see in this instance, for the first time in combination, the utilisation of a waterfall, the transport of energy to a great distance, the automatic compounding, and the coupling in parallel of the alternators by means of a reactive coil. As we proceed with our examination, we shall be able to see why this special method has been adopted, it being one which is suited to all the requirements of this particular case.

As it was possible to utilise, without great expense, a waterfall that had already been turned to account for a paper manufactory which had been destroyed by fire, the employment of alternating currents of high tension with transformers was necessary. The distance of this waterfall, which is situated at Ponts-Neufs, at about 13 kilometres from Saint Brieux, is sufficiently great to entail a loss along the line amounting, at full charge, to 20 per cent. of the total power, in order to realise a saving by the establishment of this line. This loss, which at first seems considerable, is justified by the fact that the available motive force is amply sufficient to provide for all requirements at all seasons. At the time of the year when the water is low the days are longer, and the duration of the lighting shorter, and the pond supplying the waterfall contains sufficient water in reserve to ensure the working of the lighting system. The quantity of water supplied by the little tributary streams is always sufficient to make up for the lowering of level produced during the few hours that the system works during the dry season.

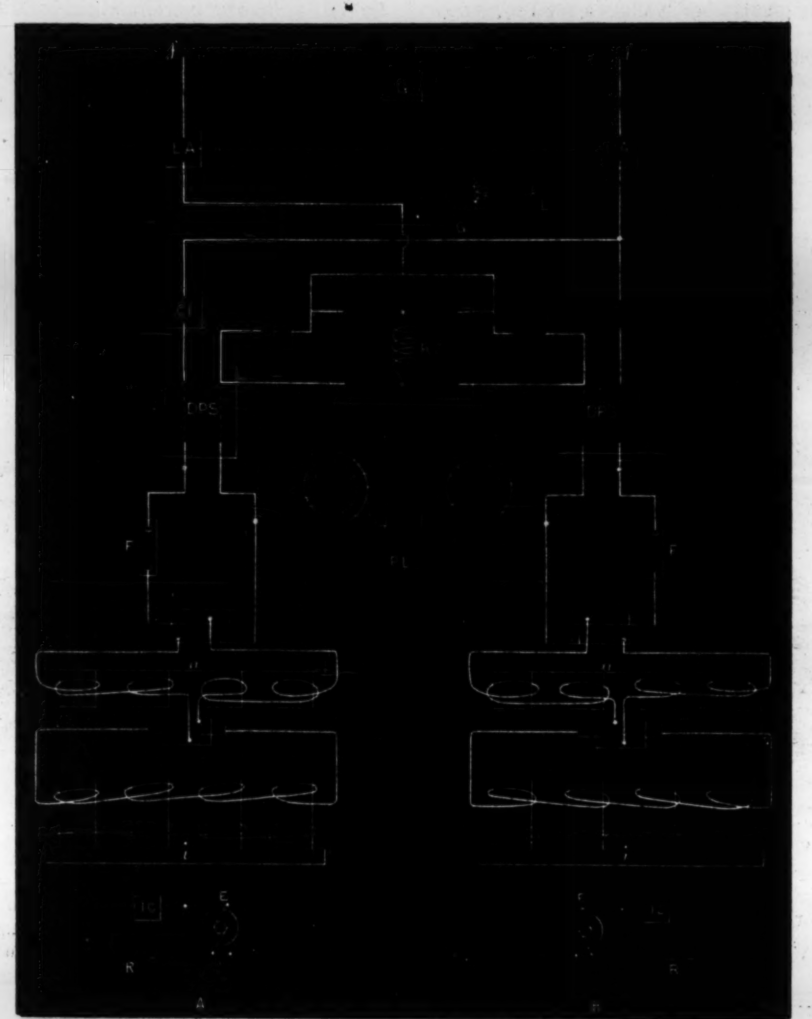
The fall at the Ponts-Neufs is about 11 metres. It works two vertical turbines of the "Hercules" type, constructed by Messrs. Singrün Bros., of Epinal. The total power of these two turbines exceeds 300 H.P. They turn at a normal angular speed of 250 revolutions per minute, which speed is kept constant by a centrifugal force regulator acting on the sluice gates, until the speed becomes normal again, and thus the quantity of water brought to the turbine is regulated according to the power to be produced.

These turbines drive two Thomson alternators of 35 ampères, the electromotive force of which varies, according to the charge of the line, between 2,100 ond 2,600 volts, with a view to maintaining at the extremity of the line, at Saint Brieux, an effective difference of potential of about 2,100 volts.

Dynamos.—Each alternating current dynamo turns at the normal angular speed of 1,050 revolutions per minute, and bears 14 inductive poles, and 14 inductive coils, thus corresponding to a frequency of 70 periods per second. The mode of excitation of these dynamos is worthy of special mention. The inductors are furnished with two distinct windings, the action of which is united.

The first winding is actuated by a special continuous current shunt dynamo which serves as an exciter. Each alternator has its dynamo and special exciter, but one single exciter is sufficient, in case of need, to excite both the alternators. The excitation of the alternator is so regulated that with an open circuit it produces exactly 2,100 volts at its normal speed, by acting upon two rheostats introduced, the first, into the excitation in a shunt circuit of the exciter, the second, into the circuit of excitation itself.

The second winding of the alternator is fed by the principal current of the line. For this purpose the circuit of the 14 armatures is cut in the middle by a current redresser consisting of two rings forming a commutator, each provided with seven teeth on which two brushes rub, these being placed accordingly, and communicating with the second excitation winding of the alternator. It is easy to see that the alternating current is thus redressed and passes through the inductors in such a manner as to increase the excitation by a quantity in proportion to the principal current supplied along the line. The winding of the inductors is calculated so that the compounding thus obtained should be greater than is required. It is reduced to the proper value by mounting a shunt in derivation on the brushes of the excitation. The diagram accompanying this article shows clearly the principle of the arrangements we have described.



f, feeder; G, earth; G_1, earth detector; R.C., reactive coil; L, lamp; P.L., pilot lamps; F, fuze; *a*, armature; *i*, inductors; A.B., alternators; E, exciter; R, shunt rheostat; L.A., lightning arrester; C.I., current indicator; S.P.S., single pole switch; D.P.S., double pole switch.

In short, then, for each dynamo there are eight wires leading to the centre of distribution; two for the rheostat of excitation of the exciter, two for the rheostat coming from the exciter introduced into the circuit of excitation of the alternator, two for the rheostat shunting the excitation by redressed currents; and lastly, two from the collecting brushes bringing the alternating current to the centre of distribution.

The Centre of Distribution.—The distributing station contains, in addition to apparatus for regulating and controlling the excitation, which apparatus we have shown in their theoretical place in our diagram in order to simplify it, all the apparatus necessary for the introduction into the circuit of either alternator, for controlling the coincidence of its phases, for the parallel coupling, for the protection of the line and the station, for the testing of the state of insulation of the line, and, lastly, for the indication of the currents and the differences of potential.

We see by the diagram that the principal wires of each alternator arrive at a double interrupter after having passed through fusible circuit-breakers. The object of this double interrupter is to insulate completely from the station the machine which is not in use. At the terminals of the alternators is mounted the phase indicator, consisting of two little transformers, the primaries of which are coupled in derivation on the terminals of each alternator; the secondaries are coupled together in tension, and two lamps of 100 volts are introduced into these circuits. The connections are so arranged that the electromotive forces are united when the alternators are in the same phase, the lamps then burn with their full brilliancy; they are extinguished when the phases are contrary, for the electromotive forces induced in the secondaries are then in opposition.

In order to place an alternator on the line, it is necessary to close the corresponding double interrupter and also the single interrupter. We will suppose that, machine A, being in circuit, it is required to connect the altérnator, B, in parallel with the dynamo, A. We begin by closing the double interrupter belonging to B, which has the effect of putting the two extreme wires of the two alternators into direct communication. (See diagram.)

We then observe the phase indicator, and when the phases coincide we turn the commutator of the *reactive coil* to the right, *i.e.*, towards the machine which we wish to bring into the circuit. This effects the coupling of the alternator, B, in derivation on the alternator, A; but when the reactive coil is introduced into the circuit of the alternator, B, this coil having great inductance, greatly impedes the passage of the current, and this coupling makes no appreciable change in the load of the alternator, B, which, notwithstanding the coupling, produced only a very feeble current. The inductance of the reactive coil is diminished by the displacement of the induced circuit, which gradually covers the inductive circuit and diminishes its resistance to the passage of the current (impedance) in consequence of the well-known reaction due to the increasing mutual induction of the two circuits. When the movable induced bobbin of the reactive coil has reached the end of its course, and entirely covers the inductive bobbin, it suppresses the reactive coil of the circuit by short circuiting it. During the displacement of the induced bobbin of the reactive coil the load is gradually distributed, and is divided equally between the two machines, so that at the end of the manipulation, if the two alternators are well regulated as to speed and excitation, half of the total current is furnished by each alternator. The two alternators are then in parallel, and we have only to close the single interrupter of the alternator, B, in order to render the communication permanent and free the reactive coil, which should only be in the circuit at the moment of the coupling, and the induced circuit of which should be brought back into the position giving the maximum of resistance (impedance). When one of the alternators is in the circuit, and we wish to remove it, all we have to do is to open the corresponding double key. The load which was being distributed between the two machines is instantly directed into one only, and as the two alternators are driven by a common axle, the transfer is effected without a break or change of speed.

The reactive coil is therefore useless for the purpose of uncoupling, but it is of the greatest service at the moment of coupling, for it substitutes a progressive action for a sudden one, and enables us to obtain from alternators what we obtain from continuous current dynamos connected in parallel by a simple variation in the excitation. We were present at several coupling and uncoupling operations, and saw that they did not produce the slightest variation in the brilliancy of the standard lamps. We even think that, thanks to the reactive coil, the coupling of the alternators might be effected without ensuring the concordance of the phases, but owing to the prudence of the staff in charge of the installation, we had no opportunity of testing experimentally the correctness of this opinion.

Next to the regulating and coupling apparatus, we must mention the controlling and the safety apparatus. For the former purpose, current indicators are established on the exciters and on the circuit of each alternator. The difference of potential at the terminals of each alternator is read on an indicator mounted in derivation on the terminals of the phase indicator, which also feeds two standard lamps. The difference of potential available at Saint Brieux will be indicated by a voltmeter placed at the works, and communicating by two return wires with the distributing box placed at the other extremity of the feeders, from which the mains supplying the various transformers branch out. The distributing station is protected by two lightning arresters, L, A, of the Thomson type. The insulation of the line is indicated by a ground detector, G_1. This ground detector is merely a little transformer with two wires in series, the thick wire being shunted through a lamp. The end of the thick wire is connected to earth, that of the fine wire may be placed by means of a commutator on one of the mains. If the insulation is good the lamp should remain dark, and it should burn with more or less brilliancy according as one of the two mains is in more or less perfect communication with the earth. If the right main is connected to earth, the lamp will burn when the ground detector communicates with the left main.

Line.—The line is wholly overhead, and supported by wooden posts with insulators consisting of double porcelain cups. The feeders are of Mouchel copper, and are each composed of a strand of 16 wires, the total section of which is 50 square millimetres. The resistance of this line is such that the loss at the full charge of 70 ampères will be about 500 volts or 35 kilowatts. We have already justified this loss, which is apparently excessive, by the peculiar conditions of the installation. We have said that the line is entirely overhead, but we must except a length of about 50 metres, which crosses a railway line. The company would not give permission for an overhead wire, so it was necessary to employ a Berthoud-Borel concentric cable, passing under the railway in a cast iron pipe.

Canalisation.—At the extremity of the feeders the line branches out into three sections along which are arranged the transformers at present 14 in number, and all of the 4,500 watts type. They reduce the potential of 2,100 volts which is supplied to them to 104 volts. Each of these transformers constitutes in itself a sort of little individual central station, the circuit of which supplies a varying number of consumers, but there is no connection between the secondaries of the various transformers. The transformers are provided with lightning protectors and circuit breakers on the primaries and secondaries, but no special precaution has been taken to guard against the possibility of an accidental contact between the primary and the secondary, with a view to the protection of the consumer.

A telephone line of course connects the works at the Ponts-Neufs with the offices of the company charged with the lighting of the town.

To small consumers the electrical energy is sold at so much per lamp per annum, according to the duration of the lighting, which lasts, according to the contracts, up to 8 o'clock in the evening (*sic*), 10 o'clock, midnight, or the whole night, the good faith of the consumers alone serving up to now as a guarantee that the lamps will be extinguished at the hour stipulated. The more important consumers will be charged according to the meter.

These are the principal points in connection with the electric lighting at Saint Brieux, the first installation established in France by the Thomson-Houston Company by means of their double excitation alternators and transformers. The installation is well arranged, and it is evident that there is no want of room. All the controlling, regulating and coupling apparatus are well within sight and reach, and the station is easily accessible from the back, which facilitates the superintendence and maintenance of the different parts.

The lighting of the town is undertaken by a local company, bearing the name of *Société d'énergie électrique de Saint Brieux*, under the direction of M. Didier-Gagon, M. Bonfante being the engineer in charge.

The technical success of the undertaking is complete, and does the greatest honour to the company and to the Thomson-Houston Company. We wish the company an equal financial success, for it seemed to us in our very rapid visit that the inhabitants of Saint Brieux left much to be desired as large consumers of light by night. Old habits have to be changed, and electricity will help in no slight degree, we will hope so at all events, to bring about these changes, on which depends in so large a measure the future of central stations supplying small towns.

COSINUS ALPHA.

RANKIN KENNEDY'S NEW ELECTRICAL DISTRIBUTION METHOD.

By RANKIN KENNEDY.

(*Continued from page* 456.)

MOTIVE POWER.

THE motors last described were all synchronising self-starting motors. Another motor employed for motive power where alternating currents are obtainable is constructed to work without any commutator or brushes. Motors working without any brushes have been devised for alternating current working by Prof. Ferraris, who proposed the employment of two alternating currents in quadrature to produce a shifting series of poles on a field magnet, on the method often described in these pages. This method is being still further developed, as would appear by the article of Hans Gorges in the last issue of this paper, p. 506. In these rotary current or rotary polar motors, the author has discovered many inter-actions which introduce practical difficulties, their action is very complicated and obscure at present, and their construction is not sufficiently perfect to enable them to be put into actual practical motor work.

The motor designed by the author for alternating current working without brushes or commutator, consists of two parts, first, a transformer, and, second, a motor, both combined in one machine. The transformer has part of its magnetic circuit mounted on the shaft of the motor, and that part carries the secondary coils of the transformer; this part of the transformer mounted on the shaft of the motor rotates and carries the secondary coils round with the armature of the motor part.

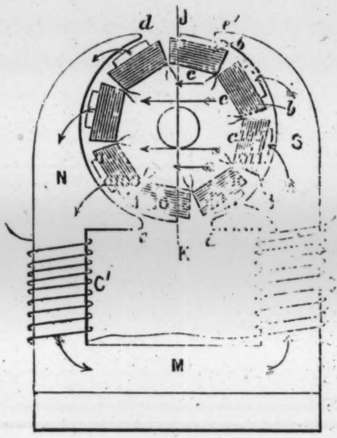


FIG. 1

Fig. 1 shows a diagrammatic view of the transformer part; M, is the part of the magnetic circuit carrying the rimary coils, C', C; the part of the magnetic circuit carrying the secondary coils is shown at *c*, *c*, *c*, and is formed of stampings of circular form having outward projecting extensions carrying the secondary coils, *b*, *b*, *b*, and mounted like an armature on spindle of motor.

It is obvious that secondary currents will be induced in these secondary coils, *b*, whether the spindle rotates or not, and that little or no inductive actions obtain in these secondary due to their revolving with the spindle of the motor; they act simply as secondaries to the primaries, C, C, on M.

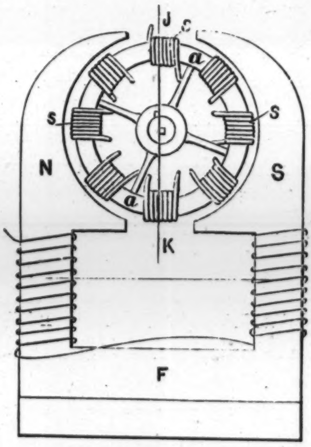
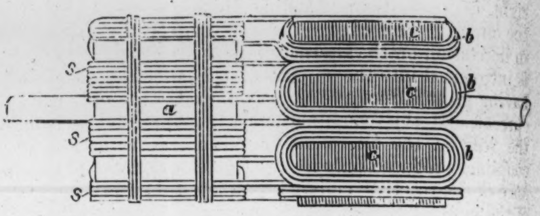


FIG. 2.

The motor part is constructed as shown in fig. 2, having a field magnet, F, wound with field coils, and a common laminated ring or drum armature, *a*, *a*, with coils wound on in sections, *s*; and there are as many of these coils on this armature as there are of coils in the secondary of the transformer portions. In the illustrations there are eight coils on the armature and eight coils on the secondary, wound on eight projections; these coils on the armature are each coupled across to a coil on the secondary, as shown in fig. 3, where *a* is the armature, and *c* the portion of the transformer mounted on the same spindle carrying the secondaries, *b*, *b*.

FIG. 3.



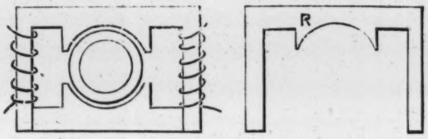


FIG. 4.

In practice, the form of field magnet used is shown in fig. 4; it is built up of stampings, R, of thin sheet iron, these are laid together alternately one up, as shown, and the next inverted, the coils being ready wound.

The action of the motor is this: The primary current in C, C, on M, induces secondary currents in the coils *c*, *c*, mounted on the spindle, these secondary currents flow in the coils on the motor armature in such a direction at any instant as to energise the armature and form poles on the line, J, K, just as in any ordinary continuous current motor. These coils, of course, are continually reversing, but the current exciting the field magnet, F (in fig. 2), is adjusted to reverse simultaneously, so that the action of this motor is much the same as a continuous current motor.

There are no inter-actions due to the revolution of the secondary in the transformer part; but there is a counter E.M.F. set up in the armature coils, due to the revolution of the armature in the field, F; this counter E.M.F. makes the motor self-regulating, as it checks the flow of the secondary currents, and that in turn checks the flow of the primary just as in any transformer; and to get the best self-regulation, the secondary portion of the transformer must be magnetically as powerful as the primary part; that is to say, the ampère-turns of secondary should not be less than the ampère-turns of the primary, and the cross-section of the cores should be equal in the primary and in the secondary parts.

These descriptions will conclude with a description of the author's electricity meters.

(*To be continued.*)

THE DESIGN OF MULTIPOLAR DYNAMOS.

By A. B. BLACKBURN.

THE paper read by Mr. Esson at the meeting of the Institution of Electrical Engineers on the 9th of this month forcibly suggests to us that the demand which modern practice now makes for large machines is constantly outstripping the advances in our knowledge of their constitutions, and that a dynamo beyond the capacity of the bipolar machine is being called for, even before the problems surrounding the construction of the latter have been thoroughly mastered, and in further contributing to our enlightenment, Mr. Esson in no small degree establishes a claim on our gratitude. He has presented to us, in a consecutive form, a series of expressions, which deal with some of the most vital points to be considered in originating new types, and has added considerably to our knowledge of the ultimate limit attainable.

To those, however, and they are probably not a few, who, through long acquaintance, have found in the bipolar dynamo a trusty friend, a feeling of regret must arise that its ordained stature should no longer permit it to maintain the front rank in supplying our increasing wants, and one is prompted by the desire to make the best defence for an old favourite, and as far as possible extend the limit of its operations in furtherance of the competition arising between it and the multipolar machine.

In regard to alternating current dynamos the case is different. Here from the first we have always been familiarised with a composite structure, and it may be regarded in the light of a promotion to find Mr. Esson harmonising the laws which govern the interaction of their armatures and magnets with those appertaining to continuous current machines.

He also lays evidence clearly before us that the same considerations apply equally to the bipolar and multipolar machine, and that the latter is nothing more than a number of small bipolar machines united in one; costing approximately the same, and theoretically having an output equal to their sum, but with the advantage of a diminution of speed inversely proportional to the number of magnets, and that as regards the carrying capacity of the armature there is no change, so that the main difference lies in the subdivision of the field. It is not, however, so much in respect of diminished cost that their claim for existence depends as on the possibility of constructing them on a larger scale, especially to supply the large currents of comparatively low electromotive force, which for the present methods of applying continuous currents is so essential, and for which bipolar machines cannot be constructed, because the number of convolutions and commutator bars are then limited to such an extent that a steady current and sparkless collection cannot be attained.

This is obviated in the multipolar machine by connecting the sections in parallel, and by making them sufficiently numerous. The sub-division of the magnets and reduction of the total induction in each then enables a sufficient number of convolutions to be provided. But it would be premature to conclude that this provision presents a solution of the whole problem, and it is to be regretted that Mr. Esson does not in his paper even hint at the possibility of the existence of any countervailing disadvantages.

Whilst on the one hand troubles engendered by too great a difference of potential between the individual commutator bars are avoided, on the other there is a danger of any want of symmetry creating such a difference between whole sections as to lead to what may be described as cross currents, whose circuit is completed within the machine, and which may be more detrimental than any mere parasitic current in a single conductor.

In the case of machines which are externally cross connected, and in which the collection is made at every pole, these currents will chiefly be due to want of adjustment of the brushes, and are therefore dependent on the skill displayed by the attendant in setting them, in the same manner which applies to the adjustment of the brushes on a bipolar machine, only as there are more of them, the difficulty is increased. Where the sections are internally cross-connected, and collection is only made at two points, care exercised in the construction of the machine to ensure perfect symmetry will obliterate them; but we are then confronted with the necessity of employing enormous commutators and a long row of brushes to carry off the heavy current. Under these conditions, it will be evident that a multipolar machine behaves very much like a battery of small dynamos connected in parallel, and that to equalise potential some form of cross-excitation or variable resistance is equally imperative.

The result is that in all probability a much larger factor of safety will have to be allowed, so that size for size they will will be at a disadvantage up to the limit to which bipolar machines can be constructed, and considering how much more up to the present has been said than done about them, there is a presumption that they have not acquitted themselves as well as could be desired.

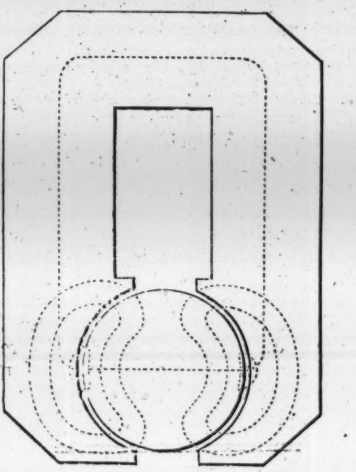
It is to be hoped that in the course of the discussion on Mr. Esson's paper something may be added to our knowledge of these points.

Committing their further development to the future, we may turn to the consideration of what is to be learnt from Mr. Esson's conclusions as to bipolar machines, and endeavour to ascertain what are the ultimate dimensions to which they can be constructed.

Taking the various proportions which he assigns and postulating a certain voltage, speed and number of convolutions, let us see where we are landed. For instance, with 100 volts and 320 revolutions and 40 convolutions—which is about as low a figure for the latter as is safe—what is the greatest carrying capacity in ampères which we can hope to reach? The answer, as drawn from his data, is about 690 ampères. Now this is decidedly low; in fact, it is scarcely necessary to remark that many machines for these volts and revolutions are and have long been working satisfactorily, giving an output in ampères fully 50 per cent. greater. The discrepancy is in part due to the very low induction which Mr. Esson advocates, but there appears to be grounds beyond this to believe that his expressions, while giving rather too heavy an output for small machines, err on the side of giving too little for large ones.

To some extent this may be due to the omission in his expression for current carrying capacity of the value of the magnetic resistance of the iron part of the armature circuit. By giving a different form to the expression, this is made more evident.

Referring to the accompanying diagram, let the current turns on the magnets be denoted by A_2, and those on each half of the armature circuit by A_1, and the magnetic resistances and total flow of lines in each by R_2, R_1, and N_2, N_1, respectively.



We have
$$\frac{4\pi A_2}{10} = N_2 R_2,$$
and
$$\frac{4\pi A_1}{10} = N_1 R_1,$$
for each side of the armature.

Whence
$$\frac{A_1}{A_2} = \frac{N_1 R_1}{2 N_2 R_2}.$$

Now if the forward induction of the magnet circuit i equal to that of the armature there will be no reversing field, and
$$N_1 = \tfrac{1}{2} N_2,$$
so that
$$\frac{A_1}{A_2} = \frac{R_1}{4 R_2}.$$

Or, adopting Mr. Esson's term, V, for the volume of current,
$$\frac{V}{A_2} = \frac{R_1}{R_2},$$
which gives what he would call the theoretical carrying capacity for a drum armature.

Going as far back as the year 1886, there may be found in the paper contributed to the Royal Society by Drs. J. and E. Hopkinson a passage preceding fig. 4, from which this form of expression is deducible, and it appears in more or less definite shape to have been present in the minds of Mr. Kapp and Mr. Swinburne, and by substitution and addition of the value of the areas, the formula (1) in Mr. Esson's paper can be closely assimilated to it. It, however, involves the assumption that the length of the armature and width of the poles are equal, or that allowance is made for any difference by introducing the necessary correction into the value of the resistances, neither is any provision made for the effect of back turns, but as both magnetising forces would be altered, and the value of R_1 would undergo a change, the omission, as was pointed out by Mr. Esson, makes little difference.

If by its aid we further proceed to consider the relations between volume of current and diameter, there appears to be grave doubts as to the truth of the constancy of their ratio which Mr. Esson has assumed. And it can only be maintained in cases where the configuration of the machines is identical, for with a given section of magnets any change in the diameter should only be made with a corresponding change in the length of the armature, and as under these circumstances the polar area will remain practically the same, it can be seen at a glance that increase in the air gap, while permitting of larger carrying capacity, owing to the necessity for more ampère turns on the magnets, causes greater leakage, so that the constancy of the ratio can only be effected if we are prepared to alter the percentage of stray field; and seeing that Mr. Esson states that the relation differs enormously in different machines, it is difficult to understand whence he can have derived the basis for the value he adopts.

By careful measurement and calculation of the different values for a given configuration, it may be possible to ascertain to what extent the factor of safety assigned by Mr. Esson is real; it appears somewhat at variance with our preconceived notions that so efficient a machine should require so high a factor as 50 per cent. This, if correct, may be due to the number of points not at present included in our expressions, and which have been enumerated by various authorities as embracing insulating spaces, clearance, leakage, shape of pole pieces, compounding, self-induction and reversing field, form of brushes, heating, and other minor sources, all of which being subject to variations, some with the type of the machine and material employed, some with age or with the hourly exigencies of working, create a necessity for a margin beyond the scope of calculation, but which should not deter us from keeping theory well abreast of practice.

THE OERLIKON EXPERIMENTS WITH VERY HIGH TENSION CURRENTS.

Mr. Brown states that in designing apparatus for producing extra high tension currents of from 30,000 to 40,000 volts pressure, it should be constructed to overcome the disadvantage attendant on all dynamos for the direct generation of high potentials, viz., when the machine is running, the handling of certain parts is attended by danger, both in relation to the machine and the dynamo tender. Hence the most ideal apparatus for the purpose is, without doubt, one which is absolutely stationary, which does not require any tending, and which is so made that without even touching it, it may be left for years in service.

This leads us naturally to the alternating current transformer. A transformer should be so constructed that it can be easily taken apart. This makes it necessary to construct separate primary and secondary coils, which are separated from each other and from the iron.

The construction of the coils should be such that any common workman can wind them on a lathe in order to eliminate the elements of expert labour for repairs.

The insulation between the two coils and against the iron should be such that a short circuit between the coils, or a contact with the iron, be made impossible, and finally the whole arrangement should be such that the apparatus may be erected in any place and under all conditions without any danger whatsoever.

A transformer built on these principles will be an ideal, safe apparatus, and from experience in the machine works at Oerlikon, it may be said that such a construction is possible.

We have now the conditions for the construction of the transformer for a potential of, say, from two to three thousand volts, or a little above, but not by any means for potentials of 20,000, 30,000 or 40,000 volts.

Even if a transformer should be able to stand such high potential, the influence of the atmosphere during its practical operation will soon short circuit it. Here now we must introduce a new factor, viz., oil as the insulating material. Oil is known to be one of the best non-conductors of electricity. It has the property of filling all pores of insulating materials, as cotton, linen, paper, &c., and excluding air and moisture. Oil is therefore capable of insulating against the influence of the atmosphere.

A well-known experiment best demonstrates these facts. Two cotton braided wires, the ends of which are twisted, are put in a glass filled with a thick resinous oil of higher specific gravity than water and heated for a few hours in order to expel all water and air out of the cotton and the oil. Over the wires are slipped two glass tubes which extend above the surface of the oil. A small quantity of water is then poured on the oil. If we now connect the upper ends of the wires to the poles of a Rhumkorff induction coil or a frictional machine, we can obtain sparks between these wires a few inches in length without puncturing the cotton insulation submerged in the oil.

This is without any doubt a proof of the highly insulating properties of certain oils.

In the experiments relating to oil as an insulator for high tension machinery, Mr. Brown placed his transformer in a cast iron box, filled up with oil, and kept it heated for hours at a high temperature. By this process many advantages are obtained.

The oil fills and penetrates all pores and fissures of the apparatus, entirely displacing air and moisture and covering the whole transformer. The possibility of puncturing the insulation is, of course, greatly diminished, and the transformer protected against influences from exterior sources, as atmosphere, dust, &c.

Of course, it is necessary to construct an insulating transformer in the very best manner possible to commence with, and not depend upon the oil insulation solely.

The coil for the low-tension current is generally very simple for the reason that for the generation of a potential of, say, 30,000 volts, by means of a transformer, we use a generator of, say, 20, 30, or 50 volts only, and therefore the primary coil of a transformer will consist of a few turns of thick wire only. Insulation can be easily obtained.

The first transformers constructed in this manner were transformers used in the Oerlikon experiments. Mr. Brown could use them immediately after they had been finished for a potential of 40,000 volts without the least difficulty.

For the conveyance of currents of some 30,000 volts it will be necessary to employ an overhead wire insulated by fluid insulators, constructed with more than one receptacle for oil.

The possible loss of current through the air appears to be much smaller than has been assumed heretofore.

Taking the efficiency of the primary dynamo and transformer at 90 per cent., the efficiency of the conductor at 97 per cent., and of the secondary transformer as 97 per cent., the total commercial efficiency works out at about 84 per cent.

From the results of the Oerlikon experiments, the successful construction of such transmission plants may be considered feasible in the not very distant future.

TEETH EXTRACTION BY ELECTRICITY; OR, BARON GRANT AND MR. F. L. RAWSON ON THE "STUMP."

> "In pity spare it, I have ne'er another,
> It is my last; my last remaining molar."—*Tootles.*

We live in an electric age, an age when everything that is done well must be done quickly. We get up in the morning and take our breakfast at the rate of fifty miles an hour in order to catch that train that won't wait, and then cannot eat our lunch because, forsooth, we have an indigestion. We then worry through the day at top speed, and naturally retire home at night to unnatural and feverish slumbers, in which we dream of having in five minutes made an immense fortune out of, say, bones (or some other equally valuable article), and wake up in a cold perspiration just as our dream terminates with the touching *tableau* of our earthly remains being comfortably interred in a metropolitan cemetery; and all this in the space of an hour. It is indeed true, we live in a nervously-electric age. Streets are now lighted by the electric spark, railways are worked with the same vital power, boats are made to navigate rivers with it, it is even used at once as a public executioner and a life renewer, and a sound and motion conveyor, but we have never yet until within this last week heard it seriously spoken of as a *tooth extractor*. Yet such is, nevertheless, the case; for electricity, with the help of Baron Grant and Mr. F. L. Rawson, is now said by them to be the finest dental operator the world has yet known. If we are to believe rumour, the Baron was so exuberant over this newly discovered dental method, that he allowed the vendor to draw his last, and, therefore, most precious molar, in order that a disbelieving public might have an ocular demonstration of the value of the process, while Mr. F. L. Rawson wept sweet tears of gentle sympathy at this veteran's commercial heroism. We were not present at the tooth extracting *séance* in question, and our information must, therefore, be candidly stated as second-hand. As may be imagined, a valuable patent of this description did not long go begging, and it is officially, though confidentially, stated in the quarter already mentioned that the public will be made to have their teeth extracted, or, in vulgar parlance, to "stump out," in order that the shareholders in the Elmore companies may be allotted "tooth extracting" shares instead of a dividend. Also in the event of a failure to bring this scheme before the public (if so national an enterprise could fail), in place of shares, Elmore's confiding investors will be one and all presented with a season ticket, allowing them to avail themselves to the full of Baron Grant's philanthropy, and Mr. F. L. Rawson's benevolence, to go and have all their remaining teeth drawn in a public-spirited manner. It will be seen from this that these two gentlemen are, perhaps, unconsciously, but, nevertheless, demonstratively, plagarising that brave and good, all-healing prophet, Sequah, and we advise the last-named to consult his solicitor respecting this infringement of his rights, otherwise the festive Baron and daring Rawson may even adopt the very methods invented by his ingenuity, and drown the pious exclamations of heartfelt praise which fall from the lips of clients who have "just had one taken out" by a fanfare on the cornet, a fantastic solo on the trombone, and the big drum beating prestissimo. We wonder, too, if our good friend, Mr. H. T. Walker, has tried the new process in question, and lost a tooth in the cause of honour, in order that he may feel doubly conscientious in giving out the prospectuses. But there, this is, after all, a serious matter, and and must be dealt with seriously. Baron Grant and Mr. F. L. Rawson are about to ask the public for *more* money for *another* process. It is not copper this time; instead of "copper depositing," it is "teeth extracting." Now we wish most solemnly to protest against this additional company fledgling emanating from the Queen Victoria Street nest, for we consider it nothing more than an absurd thing, a thing to be ridiculed and held up for the derision of all. Electric tooth extractors have been tried, and have been voted by the dental profession "no go" for decreasing the pain of operations of this kind, indeed by such means the pain of operations of this kind is intensified, and we would recommend those desirous of testing the process to make their funeral arrangements beforehand, and so save their friends both time and trouble, to say nothing of expense.—*The Lighthouse.*

Lighthouse Illuminants.—At a meeting of the Royal Dublin Society on the 15th inst., Mr. J. R. Wigham exhibited in action a new lighthouse burner he had invented, which he proved by photometric experiment, made upon the spot, possesses twice the illuminating power of the largest burners at present used in lighthouses. It is calculated that this new burner, in connection with a new system of lenses, also devised and described by Mr. Wigham will transmit to the mariner when required in thick weather a light equal to about eight millions of candles, which far exceeds in power that of the most powerful lighthouse light in the world.

THE HIGHEST ECONOMY IN THE USE OF INCANDESCENT LAMPS.

By H. WARD LEONARD.

We are indebted for the following article to the courtesy of the author. It will be issued in pamphlet form by the Edison General Electric Company in a few weeks, and, until now, it has not been supplied to any journal:—

In operating incandescent lamps of any particular make, their average life will depend upon the incandescence at which they are operated.

The higher the incandescence of the carbon filament, the greater the amount of light which will be produced by the expenditure of a certain amount of energy, and the less the average life.

Lamps can be made by any manufacturer which shall have practically any desired average life, if the efficiency be not fixed.

As we decrease the power necessary, that is, increase the efficiency, we effect a saving in the first investment and in the cost of power required to operate the lamps, but simultaneously we decrease the average life of the lamps, and hence increase the cost in operating due to lamp renewals.

It will, therefore, be evident that whenever the cost of power and the cost of incandescent lamps for renewals is fixed, there will be a certain definite efficiency and corresponding life, which for any particular make of lamp will represent the condition of highest economy in the use of the lamps.

The consumer of incandescent lamps has forcibly brought to his attention the cost of the lamps he uses for renewals, but is usually unable to determine definitely the amount and value of the power required to operate the lamps. Consequently, he is frequently *led to believe* that the *cheapest* lamp for him to use is necessarily that which gives the *longest life.* Unless the power required is the same for the different lamps, *this is not true*, and frequently consumers are operating at very poor economy, and yet believe that they are obtaining very good results, merely because their lamp breakage is small.

Let us examine this subject briefly.

The measurement of light is rated in "candle-power," and the efficiency of production of the light is rated in "watts per candle."

The number of watts required by any lamp is the product of the volts and ampères used by the lamp.

Thus a 100-volt lamp using ½ an ampère absorbs 50 watts, and if the lamp be a 16 candle-power lamp, the "watts per candle," which is the measure of its efficiency, would be $\frac{50}{16} = 3{\cdot}1$ watts per candle.

Similarly, a lamp of 24 candle-power taking 110 volts and ·676 ampères absorbs 75 watts, and has an efficiency as before, of $\frac{75}{24} = 3{\cdot}1$ watts per candle.

These two lamps, operated as indicated above, will have the same average life, because of the incandescence of the carbon, and therefore the efficiency is the same in the two instances. Let us suppose this average life to be 600 hours with the efficiency mentioned, namely, 3·1 watts per candle.

Now, suppose we take the lamp designed to be operated at 3·1 watts per candle, giving 24 candle-power at 110 volts, and instead of subjecting it to 110 volts, reduce the pressure to 104 volts. The reduction of pressure will cause a reduction in the current through the lamp from ·676 ampères to ·623 ampères; consequently, the watts absorbed by the filament will be $104 \times {\cdot}623 = 65$ watts. The candle power will be found to be 16 instead of 24 as formerly. The efficiency will be $\frac{65}{16} = 4$ watts per candle. The *average life* at this efficiency will be not less than 1,500 *hours.*

Yet it *does not follow* that the *most economical results* will be obtained by operating the lamps at *such an efficiency and life*, although at first such might be thought to be the case.

In order to investigate this question, it becomes necessary to determine the cost of power under different conditions. Perhaps the best authority on this subject is Charles E. Emery, Ph. D., who has thoroughly investigated and reported upon this question. The following values are taken from his report:

The cost of producing one horse-power for 10 hours per day for 309 days in the year, by means of a first class engine using 27 pounds of feed water per indicated horse-power per hour, is $52.15, where anthracite coal is $4.17 per ton, and where an engineer's wages are $2.00 per day. Of this $52.15, $24.06 is the cost of the coal, and $28.09 is that due to expenses outside of coal, such as wages, repairs, oil, waste, insurance, taxes, &c. That is, it costs $52.15 to produce $309 \times 10 = 3{,}090$ horse-power hours, hence one horse-power hour costs $\frac{52.15}{3{,}090} = 1.7$ cents.

The cost of the power for operating a 16 candle-power incandescent lamp will, of course, vary with the number operated per horse-power. When the lamps have an efficiency of 3·1 watts per candle, twelve 16 candle-power lamps are operated for each horse-power in the driving belt of the dynamo.

When the lamps have an efficiency of 3·6 watts per candle, 10 16-candle-power lamps are operated per horse-power; with lamps of 4 watts per candle, 9 16-candle-power lamps are similarly operated per horse-power, and with 2·77 watts per candle 13·4 16-candle-power lamps. Consequently the cost of the power will be as follows for operating one 16 candle-power lamp for one hour:

C

	For lamps of 2·77 watts per candle, *i.e.*, 13·4 lamps to H.P.	For lamps of 3·1 watts per candle, *i.e.* 12 to H.P.	For lamps of 3·6 watts per candle, *i.e.*, 10 to H.P.	For lamps of 4 watts per candle, *i.e.*, 9 to H.P.
Cost of power per 16 C.P. lamp hour, with power at 1·7 cents per horse power hour	0·129 cts.	0·14 cts.	0·17 cts.	0·19 cts.

If the average life of the lamps of 3·1 watts be 600 hours, that of the 3·6 watts lamp will be about 900 hours, that of the 4 watts lamp 1,500 hours, and that of the 2·77 watts lamp 300 hours.

Let us assume that the initial cost of a 16 candle-power lamp is 44 cents, then the cost of renewals per lamp hour would be:

	For lamps of 2·77 watts per candle, *i.e.*, 13·4 16 C.P. lamps to H.P. and 300 hours average life.	For lamps of 3·1 watts per candle, *i.e.*, 12 to H.P. and 600 hours life.	For lamps of 3·6 watts per candle, *i.e.*, 10 to H.P. and 900 hours life.	For lamps of 4 watts per candle, *i.e.* 9 to H.P. and 1,500 hours life.
Cost of lamp renewals per 16 C.P. lamp hour, with lamps at 44 cents each ...	0·146 cts.	0·073 cts.	049 cts.	0·029 cts.

Hence, the combined cost of both power and lamp renewals would be as follows:

	For 16 C.P. lamps of 2·77 watts per candle and 300 hours average life.	For 16 C.P. lamps of 3·1 watts per candle and 600 hours average life.	For 16 C.P. lamps of 3·6 watts per candle and 900 hours average life.	For 16 C.P. lamps of 4 watts per candle and 1,500 hours average life.
Power	·129 cts.	·140 cts.	·170 cts.	·190 cts.
Lamp renewals ...	·146 cts.	·073 cts.	·049 cts.	·029 cts.
Total cost per 16 C.P. lamp hour when power costs 1·7 cents per horse power hour and incandescent lamps cost 44 cents each...	0·275 cts.	0·213 cts.	0·219 cts.	0·219 cts.

Thus, under the conditions given, the *most economical lamps* to use will be those of 3·1 *watts* per candle and 600 *hours* average life.

Now, let us suppose that the cost of power varies, as it will in different locations and under different conditions. It will be noted that of the $52.15 per year for the production of one horse-power, $28.09 or 54 per cent. is independent of the cost of fuel. Let us suppose that the cost of fuel is nothing, and that the only expenses in the production of power are those due to labour, repairs, insurances, taxes, &c.

	For 16 C.P. lamps of 2·77 watts per candle and 300 hours average life.	For 16 C.P. lamps of 3·1 watts per candle and 600 hours average life.	For 16 C.P. lamps of 3·6 watts per candle and 900 hours average life.	For 16 C.P. lamps of 4 watts per candle and 1,500 hours average life.
Power	0·0684 cts.	0·0742 cts.	0·0901 cts.	0·1007 cts.
Lamp renewals ...	0·1460 cts.	0·0730 cts.	0·0490 cts.	0·0290 cts.
Total cost per 16 C.P. lamp hour when fuel costs nothing and incandescent lamps cost 44 cents each ...	0·2144 cts.	0·1472 cts.	0·1391 cts.	0·1297 cts.

It will be seen that the four watt lamp of 1,500 hours average life becomes the most economical to operate under such conditions.

Now, suppose the price of anthracite coal, or its equivalent, to be $2.00 per ton. We then have the following relations:—

	For 16 C.P. lamps of 2·77 watts per candle and 300 hours average life.	For 16 C.P. lamps of 3·1 watts per candle and 600 hours average life.	For 16 C.P. lamps of 3·6 watts per candle and 900 hours average life.	For 16 C.P. lamps of 4 watts per candle and 1,500 hours average life.
Power	0·0991 cts.	0·108 cts.	0·129 cts.	0·146 cts.
Lamp renewals ...	0·146 cts.	0·073 cts.	0·049 cts.	0·029 cts.
Total cost per 16 C.P. Lamp hour where anthracite coal, or its equivalent, costs $2.00 per ton, and 16 C.P. lamps cost 44 cents each ...	0·245 cts.	0·181 cts.	0·178 cts.	0·175 cts.

From the above figures it will be seen that the four watt lamp is the cheapest to operate under the conditions given, but the advantage is so trifling that in practice the 3·1 watt lamp would be the best to use, since the lamps fall off in candle-power somewhat in long use, and with lamps having an average life of 600 hours, the average condition of the total number of lamps on a plant would be that due to 300 hours of burning, whereas the average condition of lamps having an average life of 1,500 hours would be that due to 750 hours use, and it is evident that it will be preferable to have lamps which have averaged 300 hours of use, rather than lamps which have averaged 750 hours of use.

It will be seen by the figures given that the *life alone is a poor measure of the economy of incandescent lamp*, and that in order that a four watt lamp should equal in quality a 3·1 watt lamp, its life should be 2½ times as long, and that its average candle-power in burning its 1,500 hours should equal the average candle-power of the 3·1 watts lamp in burning its 600 hours.

In all instances quoted thus far we have assumed a cost of power based upon its production for 10 hours per day under extremely favourable conditions. In the case of incandescent lighting plants, the load changes widely, and the maximum load is on for only two or three hours. The production of power is much more expensive under such conditions than when the load is constant. Statistics from a very large number of central station incandescent lighting plants, charging an average rate of 1 cent per 16 candle lamp hour, show that the total cost of power for operating a 16 candle-power 3·1 watt lamp is 0·4 cents per hour. *The relative economy in the use of lamps of different efficiencies under average conditions of central station practice is, therefore, shown by the following table:—*

	For 16 C.P. lamps of 2·77 watts per candle and 300 hours average life.	For 16 C.P. lamps of 3·1 watts per candle and 600 hours average life.	For 16 C.P. lamps of 3·6 watts per candle and 900 hours average life.	For 16 C.P. lamps of 4 watts per candle and 1,500 hours average life.
Power	0·357 cts.	0·400 cts.	0·464 cts.	0·516 cts.
Lamp renewals ...	0·146 cts.	0·073 cts.	0·049 cts.	0·029 cts.
Total cost per 16 *candle lamp hour when the power to run a* 16 *C.P.* 3·1 *watt lamp cost* 0·4 *cents per hour, and lamps cost* 44 *cts. each.*	0·503 cts.	0·473 cts.	0·513 cts.	0·545 cts.

It will be noticed that the operating expenses are 8 *per cent. less in the case of a plant using* 3·1 *watt* 600 *hour lamps than in the case of a plant using* 3·6 *watt* 900 *hour lamps. This is equivalent to an increase in the net profits of* 12 *per cent. in the case of an incandescent electric lighting company* whose expenses are 60 per cent. of the total receipts, which is an average relation between the expenses and receipts in properly operated stations.

Attention is called to the fact that if the life of the incandescent lamp be increased, or the price of the lamp be reduced, the importance of using the high efficiency lamp rather than the low efficiency lamp becomes even more marked than in the present instance.

Thus, if the average life of a 16 candle-power lamp of 3·1 watts be 1,200 hours, and the cost of the lamp be 40 cents, it will be found that higher economy will result by operating the lamp at 2·77 watts per candle, which will reduce the life to 600 hours. This is shown by the following table:

	For 16 C.P. lamp of 2·77 watts per candle and 600 hours average life.	For 16 C.P. lamp of 3·1 watts per candle and 1,200 hours life.
Power	0·357 cts.	0·400 cts.
Lamp renewals	0·066 cts.	0·033 cts.
Total cost per 16 C.P. lamp hour when power for 3·1 watt lamp costs 0·4 cents per hour, and lamps cost 40 cents each...	0·423 cts.	0·433 cts.

In all systems having a fairly good regulation and distribution of pressure, and where coal costs from $2 upward for the equivalent of one ton of anthracite coal, the 3·1 watt lamp is the most economical.

In alternating systems as ordinarily installed, the variation of pressure is often too great to use the 3·1 watt lamp economically, and the 3·6 watt lamp should be used. Also in cases when the cost of power is extremely low, the 3·6 watt lamp should be used. It will not be found economical to operate the best makes of lamps at more than 3·6 watts per candle under any conditions met with in practice.

The majority of 16 *candle-power incandescent lamps on the market to-day require from* 57 *to* 65 *watts;* that is, to have an efficiency of from 3·6 to 4 watts, and attention is called to the fact that *in order to compare in quality with a lamp of* 50 *watts* with a guaranteed average life of 600 *hours*, there should be a guarantee of 900 *hours* average life for the 57 *watt lamps*, and of 1,500 *hours* average life for the 65 *watt lamps*, and that *even then the consumer will not be operating at the highest economy* as shown above. Furthermore, it must be borne in mind that *by the use of* 3·1 *watt lamps*, the *capacity* of a plant already using 3·6 watt lamps, will be *increased* 16 *per cent.*, and in the case of a plant using 4 watt lamps, the *capacity* will be *increased* 30 *per cent.*

To express this another way, it may be said that a *consumer* having a plant *using* lamps of 3·1 *watts*, and *changing* to lamps of 4 *watts*, not only suffers the disadvantage due to the fact that he is *not operating* at the *highest economy*, but he also immediately *increases* his investment, interest, depreciation, &c., per unit of light obtained, to the extent of 30 *per cent.* and subjects his *dynamo* to an *overload* of 30 *per cent.* with consequent greatly increased trouble and expense *due entirely to the use of the low economy lamps*, but frequently attributed to a defect in the dynamo as it is there that the overload manifests itself.

PARLIAMENTARY NOTES.

Central London Railway Bill.

In the House of Commons on Thursday last week, on the order for the consideration of this Bill, which has come down from the Select Committee,

Mr. Stuart rose to move the first of a series of amendments with reference to the running of workmen's trains on the proposed railway. He said that the Select Committee had inserted a provision for the running of three workmen's trains before seven o'clock in the morning, and three more after six o'clock in the evening. These trains were to run the distance of six miles at the uniform fare of 1d. The reason of the amendments, which he had on the paper, for increasing these facilities was that the class of persons who would avail themselves of these trains were not ordinary artisans and labourers. They were mostly messengers, under-clerks, and warehousemen employed in City warehouses and offices, who were in no better position than day labourers, but who did not begin work, as a rule, till after eight o'clock. The morning trains as provided by the Bill would not, therefore, be a great convenience to them. His first amendment was to change the three trains provided by the Bill to six. It was objected that that number was exceptionally great; but it was justified by the fact that the trains on the Central London Railway would be very short, and incapable of accommodating more than 150 third-class passengers. It was said that the railway would receive no compensation for the obligations thus imposed; but it was to be remembered that the company had paid nothing to the inhabitants of London for their tunnelling rights. When the District Railway was constructed no less than £200,000 was paid for the right to tunnel under the Embankment. He moved to leave out "three" and insert "six."

Mr. Howell seconded the amendment. He thought it effected a very reasonable extension.

Mr. Barron regretted that the chairman of the committee was not present to explain the reasons which had induced the committee to come to their decision. If the company were only able to carry a small number of passengers in each train, it must be evident that it would be much more difficult for them to cover working expenses. The committee had been bound to take into consideration the enormous expense which was necessary for the construction of the railway, and the committee felt that they had no right to ask the company to concede more than three workmen's trains. The railway, if constructed, would relieve the congestion of traffic in Oxford Street and the City, and if unreasonable obligations were laid upon the company the railway would, in all probability, not be constructed at all. He hoped that the House would maintain the committee in their decision.

Mr. Isaacs said that, though the District Railway paid £200,000 for tunnelling under the Embankment, that tunnelling itself would have been impossible, had not the Embankment first been constructed on the old foreshore of the river. It was very easy to appear as the friend of the working classes when it only involved putting a hand into other persons' pockets. The obligation of providing three trains for workmen in the morning and in the evening was as much as could be reasonably expected. These six trains practically meant 12 unremunerative trains, for, at the hours at which they were run, they would generally be empty on the return journeys.

Mr. Giles also opposed the amendment.

Mr. Gane said that no fact had been laid before the House which justified the imposition of a heavier obligation than had been imposed by the committee. The committee in what they had done in this case had gone considerably beyond anything previously done under similar circumstances, and in all fairness, before an additional burden was placed on the company, very strong grounds should be shown for doing so. He was in hearty sympathy with the spirit of the proposal to place all the privileges they fairly could within reach of the working classes, but there must be a reasonable limit, and in this case the proposed increase in the number of trains was, in the circumstances, unreasonable.

Mr. Courteney would suggest to the House whether it could alter the decision of the committee in this matter with any feeling of self-respect. The members of the committee had had before them all the evidence and circumstances in the case; they were assisted by an eminent officer of the Board of Trade, backed by all the knowledge and experience of that board in connection with railways, and they deliberately came to the decision reported. Yet the House was now asked, without any means or opportunity at the moment of examining into the facts, and really any basis to go upon, to depart from that decision. He sincerely hoped the House would not do so.

The amendment was negatived.

Mr. Stuart then moved the second amendment, to the effect that the hour at which the trains should run in the morning should be 8 o'clock, instead of 7. He contended that this amendment was not open to the objections urged against the previous one, because it would impose no additional obligation on the company. The population of Shepherd's Bush included a large number of persons, such as clerks and porters in City warehouses, messengers, &c., who did not go to work until 8 o'clock in the morning, but who were of the working classes quite as much as mechanics and labourers, and it was for the accommodation of those men in the suburbs that he moved the amendment.

Sir M. Hicks-Beach said he heartily agreed with every word the Chairman of Committees said a few minutes ago. All matters connected with the Bill had been enquired into by the Select Committee, and he trusted, in the interest and safety of the public, that the House would not alter the hour that had been fixed by them.

Mr. Barron opposed the amendment.

Mr. O. V. Morgan said the amendment would entail no additional expense on the company, but would confer an immense boon on a large number of persons who would use the railway. He hoped, therefore, it would be adopted.

Mr. Howell said the men referred to by the hon. member for Shoreditch belonged in every sense to the working classes, and needed the accommodation proposed quite as much as mechanics and labourers did the earlier trains. Moreover, the more trains the company ran the more likely they would be to make the line pay, and he believed the extension of the hour to 8 o'clock, as proposed, would be largely to their advantage.

Mr. Addison protested against the House being called upon in the absence of evidence and full information to alter the deliberate decision of a committee who had thoroughly enquired into the whole matter.

Dr. Clark said it had been admitted that the particular point in question did not come before the committee, and, therefore, he thought the House was free to deal with it. The matter was one of public interest, for it was of great importance, for sanitary and other reasons, that every facility should be given to the working classes to enable them to live in the suburbs. He supported the amendment.

The House divided, when the numbers were—

For the amendment 68
Against 148
Majority ... ... —80

The amendment was therefore rejected, and the Bill ordered for third reading.

Telegraphists.

In answer to Mr. Leng,

Mr. Raikes said: The number of first-class telegraphists at an office is regulated by the number of first-class duties to be performed at that office. The maximum salaries are regulated by the importance and position of each office, and the cost of living in the different towns. The hon. member gives certain figures showing the numbers of the classes at five towns. The reason why the numbers were so fixed at the last revision was because the figures represented the number of duties at that date. A continual process of adjustment is necessary as business develops, and several of these towns will come under review. Nottingham and Sheffield are much more important offices than Dundee, and this is the reason why the maxima are greater there. I am advised that the duties on the postal side at Dundee require the higher appointments, and that the vacancies occurred on the postal side.

The Boy Messengers and District Service Companies.

Dr. Cameron asked the Postmaster-General to explain to the House the nature of the arrangements into which he had entered with the Boy Messengers and District Service Companies for the carrying on of their business under license from the Post Office.

Mr. Raikes: In reply to the hon. member, I have to state that the arrangements in question are as follows:—The Postmaster-General grants licenses for the electric call system in London (such system not to include telephones), and, if requested, to connect the offices of the company or other persons licensed with the police stations and fire brigade stations on the same terms as those in force in private wires. The license to be for 12 years, and a royalty of £25 per annum and 2s. 6d. per instrument to be paid by the licensees. The company (or other licensees) will act as agents of the Postmaster-General to deliver single letters stamped with the penny rate of postage, provided that a messenger of the company may carry any number of letters (not exceeding six) handed in by the same sender. The company is not to make collection of letters. The costs of the legal proceedings have been ordered to be paid by the companies. I should, perhaps, add that a private Bill promoted by the Boy Messengers' Company has been withdrawn.

The Telegraph Staff.

In answer to Dr. Kenny,

Mr. Raikes said: In reply to the hon. member I have to state that I have before me now the cases of the Dublin and Edinburgh telegraph staffs. Some important questions connected with them have arisen, which present difficulty and require careful consideration. Until the difficulties are removed I can come to no conclusion, and I am therefore not in a position to say more than that I am giving to the subject my earnest attention, and shall endeavour to settle it as soon as practicable. I fear I can at present make no promises as to dates of commencement.

LONDON COUNTY COUNCIL.

Central London Railway Bill.

The Parliamentary Committee reported on this Bill. They said the Bill, as amended by the Select Committee of the House of Commons, was considered on the 16th inst., and the next step was the third reading. They reported on April 7th the decision of the Select Committee with regard to the preamble, and especially referred to the fact that they had refused to entertain the question raised in the council's petition of the ultimate purchase of the undertaking by the local authority. They had considered to what extent the opposition of the council to the Bill should be carried in the House of Lords, and, having regard to the decision above mentioned as to purchase, they did not think it advisable to raise the question again. They were of opinion that the opposition should be limited to the protection of the council's general interests, and to securing the insertion of any alterations or additions which might be necessary in the clauses of the Bill as passed by the House of Commons. They recommended that a petition be presented to the House of Lords against the Central London Railway Bill, to protect the general interests of the council in regard to sewers and other matters, which was agreed to.

LEGAL.

Oriental Telephone Company.—On behalf of a holder of vendors' shares in this undertaking, Sir Horace Davey, Q.C., applied to Mr. Justice Kekewich last Friday to declare the meaning of an agreement dated January, 1881. He said this agreement, which preceded the incorporation of the company, and formed part of the memorandum and articles of association, provided that if the holders of preferred shares did not receive a dividend of 6 per cent. for five years, any deficiency should be paid out of the profits of the company in priority to the rights to dividends of the holders of vendors' shares. For several years following the expiry of the five years the directors proceeded on the construction of the agreement for which he argued; but they had since proposed to declare dividends upon the deferred and preferred shares alike. This would defer for a considerable time the receipt of the total of 30 per cent. He submitted that if 30 per cent. was not paid during the first five years of the company's existence the after accruing profits ought to go to the preferred shareholders, postponing the dividend on ordinary shares until this amount was paid.

Mr. COZENS HARDY, for the company, said that since the expiration of the five years the company had issued further ordinary shares, which were not entitled to the guarantee. The view of the directors was that vendors' and ordinary shares were both part of the original capital, and that as such they were now bound to declare a dividend on them share per share.

In the result, Mr. JUSTICE KEKEWICH, observing that the agreement included the holders of ordinary shares then issued or to be issued, said he should, as argued by the defendants, treat all the shares as being on the same footing; in other words, he declared that any deficiency in the 6 per cent. for the five years ought to be paid not out of the dividend attributable to the vendors' shares, but out of the general profits earned by the company, all the shareholders ranking alike as to the amount of dividends they received.

AN IMPROVED ENGRAVING MACHINE.

MESSRS. TAYLOR, TAYLOR AND HOBSON, of Leicester and London, have given much attention during the last few years to the development of their patent machinery for engraving and for the mathematical division of the circle; and the efficiency of the apparatus has been fully attested by their receipt of repeat orders from the manager of the Postal Telegraph Factory, the Silvertown Company, and others of the many users of their machines. The principal features of the engraving machines were described in the ELECTRICAL REVIEW a few years ago, but their general convenience and efficiency have been very much advanced by many improvements in detail which experience has suggested.

The capacity of the machine for engraving upon articles of large dimensions has been much increased by the re-arrangement of the frame, so that it is now possible to engrave the rims of wheels and drums of several feet diameter.

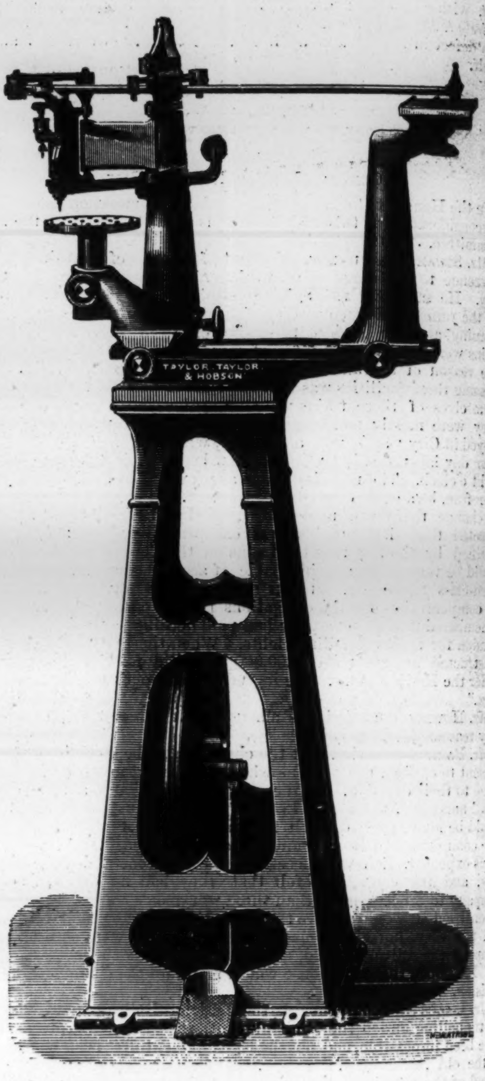
A new pattern vice has been added to the attachments for securing articles to be engraved.

A very perfect system of sharpening cutters is adopted, so that there is no difficulty in engraving even vulcanite without raising a burr; and thus, while machine engraving has the merits of great neatness, accuracy, and cheapness, it also obviates the difficulties always attending the subsequent finishing of surfaces which have been engraved by hand.

A patented gear is used to feed the cutter to its work, and to ensure uniformity in the depths and thicknesses of cuts, even on curved or other irregular surfaces.

The principle upon which this acts is that of advancing the cutter any fixed distance below the surface engraved; the distance being adjustable by a stop, and means being provided for quickly withdrawing the cutter and replacing it to cut each new letter or character the same fixed depth as measured from the surface.

In connection with the numbering of scales and dials, attachments are made for circular mathematical dividing, and recently a complete circular dividing engine has been placed on the market.



The racks of the revolving tables for dividing are cut in a machine kept sacred to that purpose, and the makers can guarantee a high degree of accuracy.

NOTES.

The Barnet Electric Lighting.—Messrs. Henry F. Joel & Co. are at arbitration with the Barnet Local Board for damages for breach of agreement. The board agreed to support Messrs. Joel's application for a license or provisional order, and this was clearly set forth in the contract, but although the Board of Trade pressed, and they (the Local Board) also pressed, the firm to obtain Parliamentary powers, yet after Messrs. Joel had prepared their license, at the last moment the Barnet Local Board rescinded their own resolution and refused to give their consent. Messrs. Joel & Co. have tried every year to obtain these powers, and of course now their contract is expiring it is too late. This is said to be the real misfortune and the main cause of non-success at Barnet, and Messrs. Joel are now going for compensation. The moral of this, to electric light engineers, is —"Put not your trust in local boards or town authorities."

Electric Lamps for Miners.—There will be an exhibition of miners' electric safety lamps at the annual meeting of the Federated Institution of Mining Engineers, to be held in London at the end of May.

Fatality at Bath Electric Light Works.—A sad accident occurred at the Bath Electric Light Works recently. A man named George Phillips, an engine driver, ascended a short ladder resting upon the engine for the purpose of lubricating some parts of the machinery, mounting about three or four steps, and standing with one foot on the ladder and the other in the air. The ladder slipped on the top a few inches to the right, and Phillips attempted to step back to the ground beneath. In doing so he probably miscalculated the distance, overbalanced, and fell upon the eight ropes which transmit the power from the engine to the dynamo. He was immediately drawn under the fly-wheel, the ropes were thrown off, and the engine stopped. The ladder, during the whole of this time, remained standing, and had Phillips maintained his position upon it no accident would have occurred. On being removed from under the fly-wheel, he was found to have sustained severe injuries, although beyond a scratch upon the face, no external wounds were noticeable, and shortly after his admission to the Royal United Hospital he died. Phillips had been in the employ of Mr. Massingham for several months. He leaves a wife and one child.

Proposed Electric Lighting in Manchester. — The Electric Lighting Sub-Committee of the Gas Committee of the Manchester Corporation have prepared a report with reference to electric lighting to be presented at the next meeting of the Council. The report says:—"The subcommittee have had interviews with numerous eminent electric engineers connected with different companies, have also inspected several electric installations, and have obtained valuable information; but the opinions and methods have been found to be so diverse, and the plant so varied, that it is difficult at present for the sub-committee to come to any definite conclusion, or to recommend to the Gas Committee the course to be pursued in carrying out the provisional order. The result of your committee's inspection and enquiries is to convince them that the utmost care will be necessary in carrying out the electric lighting order; and they respectfully suggest that in the initial stages, with view to obviate mistakes as far as possible, the best professional and disinterested advice should be sought to draw up a complete scheme including the most efficient, modern, and economical appliances for the carrying out of such order. They are of opinion that such full information is indispensable, and under these circumstances the sub-committee desire the authority of the General Committee to take such steps as are necessary to carry out these views. It was resolved that the Council be recommended to pass the following resolution: That the report upon electric lighting now presented to the Gas Committee be approved, and that the same be referred to them with full power to take such measures as in their judgment may be required to give effect to the recommendations and suggestions contained therein, and to adopt and carry out such other arrangements as may in their opinion be necessary and desirable in carrying out the Electric Lighting Order of 1890."

Electric Lighting at Exeter.—The dispute between the electric light company and the Town Council with regard to the earliest period at which the latter authority should have the option of purchasing the company's undertaking has been arbitrated upon by the Board of Trade. The council named 21 years, and afterwards 25 years, as the optional period, but the directors stood out for 28 years. As there was no prospect of an understanding being arrived at the matter was referred to the Board of Trade, which has declared in favour of 26 years being the earliest date, when the council would have to buy the plant as a going concern, with an amount equal to five years' net profits as goodwill. The second period the Board of Trade fix at 34 years, when three years' net profit would have to be paid as goodwill. If the undertaking is not bought, then the corporation can become proprietors at the end of the first term of the order, 42 years, without paying anything for goodwill.

Transformers and Spiritual Chameleons.—This is the title of a new work by Major-General H. Aylmer, and we naturally thought that the vexed question of whether open or closed circuit transformers are best would perhaps be solved, but Mr. Swinburne can fancy our editorial feelings when we found that it was only one of a series of recent religious publications, and that the transformers were not of the genus "Hedgehog."

Electric Pumping Plant at Nunnery Colliery.—The electric plant which has recently been installed at the Nunnery Colliery, Sheffield, consists of an Immisch dynamo and motor, the current being transmitted from the former to the latter by means of a cable a distance of 3,500 yards. The dynamo is compound-wound, and gives 22 ampères at 520 volts, the speed being 880 revolutions. It is driven by the fan engine, the speed being obtained by means of a countershaft with pulleys, driving two leather link belts. The power required to actuate the dynamo at full load is 22 horse-power. The large driving shaft is geared to the engine by a spiral form of friction clutch, and 37 revolutions per minute of the engines give a speed of 880 revolutions of the dynamo. There are two 7/16 bitumen insulated cables leading from the dynamo to the motor. The power from the underground motor is transmitted by means of a leather link belt on to a countershaft, which has spun gearing of 5½ to 1 on the pump shaft. The pump is a three-throw ram pump, and delivers 50 gallons of water per minute through 2,000 yards of 4-inch pipes with a head of 385 feet, this being equal to 6 H.P. in the water, neglecting friction in the pipes. The cables are taken down the shaft in pipes, and are fixed to the props in the pit with wooden clamps. They are quite slack, so as to enable them to give way in case of a fall of roof.

Telephone Subscribers' Grievances.—On Wednesday last week a meeting of subscribers to the telephone was held at the Cannon Street Hotel "for the purpose of taking such steps as might be deemed necessary" in their own interest. Mr. Hastie, who had convened the meeting, was voted to the chair. He explained that he had an office telephone at £20 a year, and a private one at his house for £12. Many in answering his circular had complained of an ineffective service, but he had a very good service at a very high price. It was absolutely necessary to have the telephone, and he thought they should demand a reduction in rental to £12 a year as a maximum. He had received subscriptions of 5s. each in support of the movement to the extent of £98, representing as near as possible 400 members, and believed it would be possible to get half the subscribers to the United Telephone Company to join. He thought they should form an association to which members could address complaints. In a letter which he had received in answer to a communication from the Postmaster-General there was this paragraph: "As to any action which the Post Office itself might be prepared to take, I am to say that the Postmaster-General could not be indifferent to a clearly expressed and general demand for the establishment by his department of a telephonic service in London, but that he regards it as premature at present to state what the charges for such a service would be." That showed quite plainly that if the telephone company would not do what they should, the Post Office would take up the matter. Mr. R. W. Leage thought the charge for an ineffective service was excessive, and Mr. G. Clarke said that his firm had inquired of country customers and found that in the provinces the rentals had been reduced from £20 to £15, and in some cases to £5 a year. It was further mentioned that in Berlin the charge was £7 per annum for a much more effective service than that obtained in this country. After further discussion the meeting, which was a large and representative one, decided to support "an association for the protection of the subscribers to the National Telephone Company." On a motion that a committee should be appointed, speakers complained that prevarication was often indulged in when subscribers were anxious to get "on" to any business house. A committee was nominated, and it was agreed that it be an instruction to endeavour to obtain the concession of direct communication between subscribers' offices and Paris.

Telephone in Melbourne.—Telephone subscribers increase rapidly in Melbourne. In 1889 they numbered 1,670, and the receipts were £25,236; in 1890, 1,903, and the revenue was £29,000.

Electric Lighting at Southampton.—The contractors for the Southampton Electric Light and Power Company have, by way of influencing business, resolved to supply the first 50 consumers with the electric light free of charge from the date of opening, April 27th.

Electric Lighting at Poole.—At a meeting of the Town Council last week, a letter was submitted from the Board of Trade with reference to a proposal made by the promoters of the Poole and Bournemouth electric lighting provisional order. The board stated that they would be glad to be favoured with the observations of the urban sanitary authority on the subject at their earliest convenience. The company proposed to form a local syndicate for the district, and asked the council for their consent, which was granted.

The Use of Electricity in the Suez Canal.—The British Consul at Port Said, in his report gives further statistics, showing how rapidly the electric light is being adopted to shorten the passage through the canal. To take extreme examples, we find for the nine months of 1887, when the regulations came into force, that 395 used the light, while last year it was utilised by 2,836 out of a total of 3,389 vessels passing through. Most of the vessels obtain the apparatus from the shipping agents at Port Said at a uniform rate of £10.

Electric Light at Dunston Flour Mill.—The Co-operative Wholesale Society's flour mill at Dunston-on-Tyne has been lighted throughout by Messrs. Ernest Scott and Mountain, of Newcastle. This installation is the largest in a flour mill in the United Kingdom, and is very complete in its details, the total installation consisting of about 600 16-C.P. incandescent lamps. The generating plant consists of three vertical engines, two of which are compound, and each capable of working up to from 60 to 70 indicated horse-power. The third engine has a single cylinder, and works up to 15 horse-power. The two larger engines drive on to two of Messrs. Ernest Scott and Mountain's Tyne compound-wound self-regulating dynamos, each constructed to run, when lightly loaded, 400 16-C.P. incandescent lamps, but is capable of working up to 600 incandescent lamps in case of emergency, so that under ordinary circumstances one dynamo and engine would be powerful enough to feed the whole of the incandescent lamps ordinarily used. When the whole of the lights are required, both engines and dynamos will be run lightly loaded, and in case of a breakdown occurring, one engine and dynamo would then be able to carry the whole load. The jetty and mill-yard is lighted with ten 2,000 C.P. Tyne arc lamps, the current being supplied by a compound-wound Tyne dynamo, driven by the small vertical engine. By a special method of dividing the circuits, the different portions of the mill are independent of each other, and can be switched on or off by the dynamo attendant from the engine room, and in the event of any accident occurring to any of the circuits, this would not affect the general lighting of the mill. A very complete system of electric bells has also been fitted by the same firm. There are in all 30 bells with 5-inch gongs and two bells with 9-inch gongs. The small bells are placed in the different departments throughout the mill, the two large bells being placed in the engine room. When it is proposed to start the engine the engine driver presses the push which rings the whole of the bells in the north mill, and a second push rings the bells in the south mill. The men in charge of the various departments then ring back to an indicator, when the engine driver sees that all the drops are down he knows everything is clear, and his engine can be started. In the event of an accident, a man in any portion of the mill can ring one of the large gong bells, when the engine is at once stopped. The installation throughout has been carried out in a most complete and satisfactory manner, and has given great satisfaction to the officials connected with the co-operative society and their engineer, Mr. John Thompson, under whose supervision the work has been carried out.

Electric Light in Bombay.—There is some talk of lighting the streets of Bombay by electricity.

The Compensation Case.—The compensation case mentioned in our last issue, brought by the Rochester Company against the South-Eastern Railway Company, has resulted in an award of £7,000.

Lectures on the Dynamo.—Prof. Silvanus Thompson continued his lectures at the Royal Institution last Saturday. The lecturer dwelt chiefly on the design and construction of modern dynamos, and the principle of the magnetic circuit.

O.S.A. Association.—A smoking concert will take place this evening at Mason's Hall Tavern, Basinghall Street, at 7.30 o'clock. A good programme has been provided, and we hope that members and their friends will assemble in force.

Coastguard Communication.—It is said that Sir Edward Birkbeck has given notice in Parliament of a resolution for the establishment of telephonic and telegraphic communication on the coasts between all coastguard and signal stations. It is certainly necessary that steps should be immediately taken to give greater facilities for the more speedy employment of lifeboats and rocket apparatus.

The Fire at West Drayton.—Owing to the disastrous fire which occurred at the beginning of the year in the West Drayton works of the Electrical Engineering Corporation, Limited, it has been resolved to go into voluntary liquidation with a view to reconstruction. The damage was estimated at £21,000, but one of the fire offices contests the claim; at the best it is expected there will be a very considerable loss.

Oil Insulation for High Tension Transformers.—Prof. Elihu Thomson remarks that reference is made to the use of oil in converters, in connection with the accounts of the high-pressure experiments of Mr. C. E. L. Brown, at the Oerlikon Works. It may be interesting to our readers to learn that the use of oil in converters was the subject of a patent applied for by him on May 9th, 1887, or about four years ago, the number of the United States patent being 428,648.

An Entirely Novel Proposal.—A certain J. T. N has written an article in a recent number of the *English Mechanic*, under the heading "A New Bi-Metallic Conductor." As an instance of much-ado-about-nothing, written by a writer who must have kept his eyes and ears fast closed for some years past, the article in question affords an excellent example. The idea of compound wire approaching in strength that of steel with the conductivity of copper is ancient history; as almost every telegraphist knows, it was first put forth and carried into effect by Siemens, and more recently a line of compound wire manufactured by electro-depositing copper on a steel core was erected for telephonic purposes between New York and Chicago, a fact which is pretty generally known. Why then do we hear at the present day so little of this compound wire? For the simple reason that hard drawn copper is found to answer the object in view far better than anything else. In the article referred to we are informed that "An entirely novel proposal has recently been made by a French engineer—Mons. Edouard Martin—which, it is alleged, is likely to become rapidly and widely adopted, since it refers to a really practical solution of the problem of wire conductors, and is not merely 'another new scientific nostrum.' Mons. Martin has devised a compound or bi-metallic wire, which consists of a steel core sheathed in copper. This, it is said, combines the desirable advantage of lightness, high mechanical resistance, and cheapness, with a sufficiently low resistance to current for all ordinary practical purposes. The figure (a section of wire) will give our readers at once a clear idea of this invention, which, like so many other 'good things,' appears to be extremely simple, and one is led to wonder that it has not been adopted long ago." We wonder also!

The St. Cecilia Orchestral Society.—This society (Central Telegraph Office) has announced an orchestral and vocal smoking concert for Saturday, May 2nd prox., to be held at Anderton's Hotel, Fleet Street. This entertainment will practically wind up what has been a busy and successful season.

Stolen Correspondence.—Messrs. O. Berend & Co., of 61, Fore Street, E.C., have had to charge two of their *employés* with stealing letters from their letter-box, and as they have reason to believe that some hundreds have been destroyed, they are issuing a circular requesting anyone who may have sent them a communication of any kind without receiving a reply to report the circumstance to them at once.

The Electric Light in Birmingham.—The Mayor of Birmingham formally opened the works of the Birmingham Electric Supply Company on Wednesday. It is the first public installation in the town, and was erected under the concession obtained by Messrs. Chamberlain and Hookham. The installation has been designed and the erecting superintended by Mr. J. C. Vaudrey, upon similar lines to those which have proved satisfactory in Liverpool. The boiler house is 41 feet by 77 feet, in which three steel Lancashire double-flued boilers have been erected, each 28 feet long by 7 feet 6 inches diameter. Seatings and flues have been built for double the number. The generating room contains three steam dynamos, with complete foundations for four further plants. Each dynamo is capable of supplying 1,500 16-candle-power incandescent lamps. The dynamos are worked by "Willans" engines, erected on the same bed as the dynamo, and which, with a steam pressure of 120 lbs., run at 350 revolutions per minute. The current is distributed through 12 pairs of feeding mains, which supply the various distributing lines in the district. There is also a battery room, in which a number of Crompton-Howell accumulators are in process of arrangement. The mains used are on the Crompton and Callender system. Between the service-box and the consumers' premises there is a lead "cut-off," which fuses and disconnects the service in case of any accident leading to an excessive current. Inside the premises of consumers the services are laid under the insurance rules, and the current is measured by meter. The meters will be tested under the supervision of the City Council, who have appointed Mr. Henry Lea as their inspector under the electric lighting order. The charge for the light will be 8d. per unit.

A Possible Coincidence.—There is one point to which we did not allude in our Editorial note last week when replying to Mr. Elmore's choice example of the "Polite Letter Writer," and to this we will now hark back. He made mention of the "Marchant" engine, but it will probably turn out that this was an ill-advised step, for it is curious to note how at times things which appear utterly dissimilar bear a strong family likeness in at least one respect. The wonderful economic results said to be obtained from that motor were arrived at by means of a brake which gave incorrect representations. Two of our friends who tested the engine for us with Marchant's own apparatus, as was stated at the time were, with a number of excellent mechanical engineers, deceived, and we fathered the mistake. No long time elapsed, however, as Mr. Elmore possibly remembers, before the error into which we were led was discovered, the engine placed unreservedly in our hands, proper tests made by ourselves, and the absurdity completely exposed in the REVIEW and in *Engineering*, whose well-known representative accompanied us to see the last act in that farce. That is how we "boomed" it. Now, although we do not say that the Elmore process *per se* is not genuine, *i.e.*, that copper is not deposited by it, we do insist that, unlike the case of the Marchant engine, we have not in this instance made a mistake, and it would be well for Mr. Elmore to bear in mind the fate of that so-called revolution in steam motors which he has thought fit to unearth and the share the ELECTRICAL REVIEW took in bringing it about, fortunately before the investing portion of the British public was fleeced by taking shares in either English or foreign Marchant Companies. The Elmore process is dubbed revolutionary by its advocates; the time cannot be far distant when the phases through which it has yet to go will be completed.

Damaging Insulators.—Two boys were fined 15s. 6d. each at the Warrington Sessions for damaging telegraph insulators.

The Brush Electrical Engineering Company.—His Grace the Duke of Marlborough has accepted the position of chairman of the Brush Electrical Engineering Company, Limited, in succession to Lord Thurlow, who has resigned his seat at the board of that company.

Crystal Palace School of Engineering.—Sir Douglas Fox presented the certificates for the Easter term to the successful candidates last Saturday. The report of the examiners stated that the number of students which had attended the lectures was 48, of whom 43 were eligible for examination and 23 had passed. The work done in all branches of the school is said to be highly creditable. Since 1881 the number of students has nearly doubled.

Electric Lighting at Leamington.—The Board of Trade will not refuse the applications of the Corporation and the Midland Electric Light Company for provisional orders, as mentioned in our columns a few weeks ago. Major Marindin recently made an inquiry into the causes of dispute which had arisen at Leamington; it is supposed, therefore, that the result of the inquiry is shown in the decision of the board.

Electric Tell-tales.—Messrs. Cox-Walker are at present completing the erection of one of their special ink-recording electric tell-tales for 28 stations at the Sussex County Asylum, Hayward's Heath, and are extending the branches of a similar-sized tell-tale at the Worcester County Asylum, Powick. They are also engaged in the installation of the electric light at Craig Crook Castle, and in alterations and additions to the electric lighting of the North British Distillery, Edinburgh.

The Jablochkoff Transformer Patent. — The Privy Council have fixed May 13th for the hearing of the petition for the confirmation and prolongation of the Jablochkoff patent. It is many years since the confirmation of any patent was granted; in fact, in the new Act, the clause was struck out. But the Privy Council have power to confirm a patent even if prior publication can be shown, provided they think the case sufficiently meritorious. In this case a description was published in several journals, taken from the accounts in France, only a few days prior to the filing of the English patent. By a curious accident, the cover of the patent is dated May 2nd, which was prior to publication, instead of May 22nd, the correct date.

Life of Incandescent Lamps.—In the manufacture of incandescent lamps, success may be said to depend on several small points. The exhaustion, we know, must be as complete as possible to insure long life and reasonable efficiency. During the exhausting process it is the usual practice to heat the carbon filament to incandescence, in order that all air contained in the substance may be expelled. It has been found that if the filament is heated at too early a point during the exhausting process it produces a more or less porous condition of the carbon, and that a lamp made in this manner has neither a very long life nor a high degree of efficiency after having been in use for a short time. As an improvement on this, the globes are exhausted to as great a degree as may be, and in as short a time as possible; then the current is passed through the carbon, and it is brought to incandescence for a few moments while the vacuum pump is still working. The vacuum pump used in this process is wholly mechanical and very quick acting, and is reported to be much quicker in its action than the mercury pumps commonly in use for this purpose. From two sets of lamps made from similar filaments, a writer in the *Stationary Engineer* has discovered that one set exhausted in the usual way by mercury pumps, while the filaments were heated by the current, the other set treated with the mechanical pump and the current sent through the filament just previous to sealing the lamps, showed in the latter case the highest efficiency and longest life. The reasons for this may be inferred to have been that in the former case the filaments were partially disintegrated in the rarefied atmosphere.—*Scientific American.*

The Fiske Range Finder.—We have received a copy of the report presented to the Ordnance Bureau of the United States Navy concerning the Fiske range finder. The tests were conducted on board the U.S. *Baltimore* by a committee consisting of Lieut. S. H. May, Lieut. H. O. Dunn, and Mr. J. B. Patton. After describing the range finder, full particulars of which appeared in the REVIEW for February 21st, 1890, the committee say that the experiments show that the instrument when in good order, and when pointed accurately, will give reliable results within 3 per cent. in ranges less than 5,000 yards, or at greater ranges when adjusted skilfully; that it can be easily kept in good order when properly installed, and the details corrected as suggested at the end of the report, and that with an officer to look out for setting up the instrument, it may be worked by any two sailors after a little instruction and practice. The following suggestions are offered:—That the instrument be fully installed and adjusted, and the lead wires cased in moulding below decks. That the telescopes be fitted with a screw arrangement for focussing, and the telescope supports be made stronger. That the range scale be larger if possible, and the voltmeters be made in a stronger case. That a reliable telephone or speaking tube connect the two instruments; unless the telephone is distinct a speaking tube will be better. The instruments should be provided with a suitable cover, so that the telescopes, bells, and telephones could be left connected up ready for immediate use, and the instruments entirely protected from weather and accidents. A better resistance box with a greater range be placed on the voltmeter circuit, and a current reversing key be placed in a convenient place near the voltmeter. The bases of the pedestals should be larger, with more holding-down bolts, so as to make it less likely to be knocked out of position by accidents. One of the pin-holes in the head of the instrument should be made in an adjustable plate, so that it could be brought to exactly 180° from the other.

NEW COMPANIES REGISTERED.

The Collier Audible Telephone Syndicate, Limited.—Capital £9,000 in £100 shares. Objects: To carry on the business of a telephone, telegraph and electric light, heat and power manufacturing and supply company; to acquire the inventions of Mr. A. T. Collier in respect of improved telephonic receivers and transmitters; to establish, work, manage, control and regulate telephone exchanges and electric light works; to construct, maintain, lay down, carry out, work, sell, let on hire and deal in telephones, cables, wires, lines, stations, exchanges, accumulators, lamps, meters and engines; and to carry on the business of electricians, mechanical and general engineers. Signatories: F. F. Mathieson, Bartholomew House, E.C. (1 share); H. S. Staples, Spondon (5 shares); H. Bishop, 41, Coleman Street, E.C. (1 share); H. S. Fisher, Sutton Court, Sutton (1 share); H. C. Halse, 61, Cheapside, E.C. (1 share); A. J. Bowen, 28, Moorgate Street, E.C. (1 share); A. H. Collier, New Cross, S.E., (1 share). The company forthwith adopts an agreement, dated the 2nd ult., between A. T. Collier of the first part, the London and Colonial Finance Corporation, Limited, of the second part, and W. H. Johnson of the third part. The number of directors is not to be less than 2 nor more than 5. Qualification £200. Remuneration to be determined from time to time at general meeting. Mr. A. T. Collier is the first managing director with a remuneration of £400 per annum. Registered on the 16th inst. by Leslie, Antill and Arnold, solicitors to the company, 1, Gresham Buildings, Basinghall Street, London, E.C. Office, 5A, Coleman Street, E.C.

Carbon Electric, Limited.—Capital, £20,000 divided into 3,000 preference and 1,000 deferred shares of £5 each. Objects: To purchase Mr. H. J. Chappell's recipes for the manufacture of carbon; to purchase the plant and machinery on his works in Devonshire; to manufacture and sell carbon rods for electric arc lamps, carbon plates for use in electrical batteries and carbon generally for electrical, sanitary, and other purposes. Signatories (with 1 share each): C. H. W. Biggs, Globe Lodge, Champion Hill, S.E.; J. C. Cole, 31, Snow Hill, E.C.; G. J. Conlon, 60, Warwick Road, Kennington; F. Webster, 7, Stanhope Terrace, N.W.; A. W. Cole, Shanklin Villas, Walthamstow; H. C. Buckworth, 48, Lorne Road, Stroud Green, N.; A. Gowlland, 24, Moorgate Street, E.C. The number of directors is not to be less than three nor more than five, the first being H. J. Chappell, G. J. Conlon, J. C. Cole, and C. H. W. Biggs. Qualification, £125: remuneration, £100 per annum each, with £50 per annum in addition for the chairman. The first managing director is H. J. Chappell, whose remuneration is to be fixed at general meeting. Registered on the 15th inst. by Robinson and Stannard, 19, Eastcheap, E.C. Office, 24, Moorgate Street, E.C.

Berkeley Gas Works, Limited.—Capital, £4,000 in £1 shares. Objects: to adopt an agreement dated the 23rd March, 1891; to manufacture, sell and supply gas and light in Berkeley and neighbourhood, and to carry on, at or in the said borough and tythings, the business of suppliers of electric light in all its branches. Signatories: J. Moffatt, Churchdown, Gloucester (750 shares); Mrs. Moffatt, Churchdown (25 shares); H. Moffatt, Kingsholm, Gloucester (393 shares); W. Moffatt, Woodville, Stroud (393 shares); Miss E. A. Moffatt, Berkeley (719 shares); Mrs. Stein, 45, Shirlock Road, Haverstock Hill, N.W. (393 shares); A. M. Moffatt, Berkeley (327 shares). The regulations of Table A mainly apply. Registered on the 17th inst. by Moulton and Sons, 37, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

The Liverpool Electric Supply Company, Limited.—The annual return of this company, made up to the 9th ult., was filed on the 7th inst. The nominal capital is £200,000 in £5 shares. The whole of the shares have been taken up, upon 10,000 of which the full amount has been called, and upon the remainder £3 per share has been called. The calls paid amount to £139,400 10s., and unpaid to £599 10s. Offices, 15, Highfield Street, Liverpool.

The Crompton-Howell Electrical Storage Company, Limited.—The first annual return of this company, made up to the 4th of August, 1890, was filed on the 6th inst. The nominal capital is £19,600, divided into 19,000 ordinary shares of £1 each, and six founders' shares of £100 each. 12,007 ordinary and six founders' shares are taken up, and upon 4,007 ordinary shares 15s. per share has been called; £600 is considered as paid on the founders' shares, and £6,000 is considered as paid on 8,000 ordinary shares. The calls paid amount to £3,004 10s., and unpaid to 15s. Office, Mansion House Chambers, Queen Victoria Street, E.C.

The Westminster Electric Supply Corporation, Limited.—The annual return of this company, made up to the 11th ult., was filed on the 6th inst. The nominal capital is £300,000 in £5 shares; 42,953 shares have been taken up, upon 100 of which the full amount has been called, and upon the remainder £4 per share has been called. The calls paid amount to £170,332 and unpaid to £1,835. Office, 2, Victoria Mansions, Victoria Street, Westminster, S.W.

The Vaughan-Sherrin Electrical Engineering Company, Limited.—The registered office of this company is now situate at 37, Tabernacle Street, London, E.C.

The Electricity Supply Corporation, Limited.—The first annual return of this company, made up to the 6th January, 1891, was filed on the 8th inst. The nominal capital is £100,000, divided into 9,900 ordinary and 100 founders' shares of £10 each. 259 ordinary shares have been taken up, upon 209 of which the full amount has been called, and upon the remainder £1 per share has been called. All the calls have been paid, amounting to £2,140. The registered office is now situate at 12, Maiden Lane, Covent Garden, W.C.

The Llanelly Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 11th March, 1890, was filed on the 7th inst. The nominal capital is £15,000, divided into 10 "A" and 14,990 "B" shares of £1 each. 7 "A" shares have been taken up, but upon these no call has been made. Office, New Dock, Llanelly, Carmarthen.

The Lancashire and Cheshire House-to-House Electricity Company, Limited.—The annual return of this company, made up to the 13th January, 1891, was filed on the 9th inst. The nominal capital is £100,000, divided into 19,900 ordinary and 100 founders' shares of £5 each. 7 shares have been taken up, but upon these no call has been made. The registered office is now situate at 15, St. Helen's Place, E.C.

The Liverpool House-to-House Electricity Company, Limited.—The annual return of this company, made up to the 13th January, 1891, was filed on the 9th inst. The nominal capital is £100,000, divided into 19,900 ordinary and 100 founders' shares of £5 each. 7 shares have been taken up, but upon these no call has been made. The registered office is now situate at 15, St. Helen's Place, E.C.

The Irish House-to-House Electricity Company, Limited.—The annual return of this company, made up to the 1st December, 1890, was filed on the 9th inst. The nominal capital is £100,000 divided into 19,900 ordinary and 100 founders' shares of £5 each. Seven shares have been taken up, but upon these no call has been paid. Office, 15, St. Helen's Place, E.C.

The Western House-to-House Electricity Company, Limited.—The statutory return of this company, made up to the 11th December, 1889, was filed on the 9th inst. The nominal capital is £100,000 divided into 19,900 ordinary and 100 founders' shares of £5 each. Seven shares have been taken up, but upon these no call has been made.

The first annual return, made up to the 13th January, 1891, was also filed on the 9th inst., but no change has been made, either in the shares taken up or in the holders of shares. Office, 13, John Street, Bristol.

The Yorkshire House-to-House Electricity Company, Limited.—The registered office of this company is now situate at 32, Park Row, Leeds.

The Northern House-to-House Electricity Company, Limited.—The registered office of this company is now situate at 21, Grainger Street, Newcastle-upon-Tyne.

CITY NOTES.

The Metropolitan Electric Supply Company, Limited.

The report of the directors states that the directors have the pleasure to submit to the shareholders a statement of the company's accounts for the period commencing the 1st October, 1889, and ending the 31st December, 1890.

The form in which this statement is presented is that prescribed by the Board of Trade under the provisions of the Electric Lighting Acts of 1882 and 1888.

It should be remembered that the period under review commences one month after the date when Parliamentary powers were granted, and comprises the time during which the greater portion of the company's works of construction were being carried out. The growth of business may best be realised by comparing the gross revenue for the last three months of 1889, which was £2,866 15s. 7d., with the corresponding period of 1890, when it amounted to £10,726 19s. The number of lamp connections which, at the close of 1889, were 14,000, amounted at the close of 1890 to 48,000. This number has been since increased to 58,000, and the demand for the light in the company's districts is steadily on the increase.

Having regard to the fact that the period under review has been mainly one of construction, it is a matter for congratulation that the company's income, which was to a great extent the result of the last three months' working, has resulted in a profit, which, though a small one, gives the strongest grounds for confidence in the immediate future.

The earnings of the first three months of the present year are so encouraging that the directors have decided to make an interim distribution of two shillings per share, which will be paid on the 1st May next.

The company's stations at Whitehall, Sardinia Street, Rathbone Place, and Manchester Square, are now completed, and their working has so far given great satisfaction to the board. It is confidently anticipated that the new station for the Paddington district, the machinery for which is in a forward state, will be at work in time for next winter's lighting. These stations, with the mains and other necessary plant, will about absorb the company's present issue of capital, but, as the demand for electric lighting increases, the directors will be prepared to recommend steps being taken to meet it.

In accordance with the articles of association, the following directors, viz., Alderman Sir Robert N. Fowler, Bart., M.P., J. E. H. Gordon, and J. C. Parkinson, Esq., retire from the board. Sir Robert Fowler and Mr. Parkinson, being eligible, offer themselves for re-election. The directors regret that Mr. Gordon, owing to his increasing business as a consulting engineer, has considered it advisable not to seek re-election; he will, however, continue to act as one of the company's consulting engineers.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., retire, and offer themselves for re-election.

ABSTRACT OF ACCOUNTS from October 1st, 1889, to December 31st, 1890.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
To Expenditure per last account	156,132	15	10
,, Further expenditure to December 31st, 1890 ...	207,753	7	8
,, Balance	4,130	5	6
	£368,016	9	0

Cr.	£	s.	d.
By Ordinary shares	367,016	9	0
,, Founders' ,, ...	1,000	0	0
	£368,016	9	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To Generation of electricity, &c.	21,040	17	9
,, Distribution of electricity	60	14	11
,, Proportion of rents, rates, and taxes	2,905	19	10
,, Proportion of management expenses	3,049	9	8
,, Proportion of law and parliamentary charges ...	20	0	0
,, Special charges	333	6	11
,, Balance carried to the revenue	136	5	5
	£27,546	14	6

Cr.	£	s.	d.
By Sale of current per meter, 7½d. per B.T.U. ...	10,327	15	11
,, ,, ,, under contracts	15,954	16	11
,, Rental of meters, &c.	1,028	11	8
,, Transfer fees	100	0	6
,, Rents receivable	135	9	6
	£27,546	14	6

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Bank charges and commission	23	0	11
,, Allowance to electric light customers	704	4	7
,, Bad debts	159	10	2
,, Balance applicable to dividend on ordinary stock or shares	461	10	2
	£1,348	5	10

Cr.	£	s.	d.
By Balance from revenue account	136	5	5
,, Interest on money at deposit	654	9	3
,, Discounts	557	11	2
	£1,348	5	10

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
To Capital account	368,016	9	0
,, Temporary loans	25,000	0	0
,, Sundry tradesmen and others, on the construction of plant, machinery, fuel, &c.	24,014	3	1
,, Sundry creditors on open accounts	996	9	7
,, Net revenue account, balance at credit thereof ...	461	10	2
	£418,488	11	10

Cr.	£	s.	d.
By Capital account	363,886	3	6
,, Cash at bankers	5,830	17	1
,, Cash in hand	11	15	8
,, Sundry debtors for amounts paid on contracts in course of completion	3,865	13	9
,, Sundry debtors for current supplied	10,394	5	10
,, Other ,, ...	254	19	5
,, Stores on hand	7,377	16	5
,, Preliminary expenses	5,052	10	4
,, Deposits (provisional orders, vestries, &c.) ..	21,814	9	10
	£418,488	11	10

Eastern Extension, Australasia and China Telegraph Company, Limited.

The thirty-fifth ordinary general meeting of this company was held on Wednesday last at Winchester House, Sir John Pender (chairman of the company) presiding.

The notice convening the meeting having been read and the minutes of the last two previous ones read and confirmed,

Sir **John Pender** said: Before asking the shareholders to approve of the report he would put some figures before them, so that they might better understand what had been done during the past six months. The gross receipts for the past half year had been £279,095 against £264,103 for the corresponding period of 1889, showing an increase of £14,492, which was partly due to profit on exchange during the temporary rise in the value of silver, and partly to increased traffic with Australia. The working expenses had been £74,090 as against £73,498, an increase of £592, due to various small things at different stations. The net revenue for the past half year was £166,807 as against £146,144 in 1889, an increase of £20,663, which was explained by the additional revenue already referred to, and the disappearance from the past half year's accounts of the item £6,500 charged in former accounts for the interest on sinking funds in connection with the 5 per cent. debentures paid off last year. The nett saving on this account, as mentioned at the last meeting, was £5,000 a year. The usual interim dividend had been distributed during the past year making, with the dividend now proposed, a total of 5 per cent., which, with the bonus of 4s. per share, would make a dividend of 7 per cent. After taking from revenue £100,000 upon account of Madras-Penang duplicate cable and £1,120 for a new land line at Banjoewangie, and additions to staff quarters, there remained a balance of £25,007, which had been carrried to general reserve fund, which stood now at £495,239. This fund had during the year been credited with £65,130 and debited with £280,004. At the end of 1889 this fund had amounted to £710,113 interest on investments during the year had been £187,876, profit on sale and investments £21,337, and the balance from revenue £25,007, a total sum of £775,243. This, less the cost of the New Zealand duplicate cable of the Madras-Penang and the partial renewal of other cables, altogether £280,000, left the fund at £495,239. In addition to this, nearly a million sterling had been taken from revenue for cable renewals and duplications since the company was formed. The revenue for the past year had been the best the company had ever had, the gross revenue, £533,951, being £27,458 in excess of the best previous year—1885—when the tariffs were in force, which were subsequently reduced by the Berlin conference. Referring to the issue of 4 per cent. debentures to redeem their 6 per cent., he said he had told the shareholders the last time he met them that these debentures were coming on the market. They came at a time when the Bank rate was 6 per cent., and everybody buttoning up his pockets, and instead of making investments realising, the result being that a risky conversion was attended with considerable success, the whole stock being taken at par by shareholders. An official quotation had been taken, and they now stood at 5 to 7 prem. With the exception of a few hundreds of the 6 per cent. lodged at the company's bankers, they were all paid off. By this operation an annual saving of £6,400 had been effected, making, with the £5,000 already referred to, £11,400. A further drawing of 320 Australian Government subsidy 5 per cent. debentures had taken place on the 7th inst., and would be paid off on the 1st July. This left £354,000 outstanding, the original amount having been £640,000. The negotiations so long in progress for a reduction of rates to Australia had been brought to a successful termination, and the reduction would come into force from the 1st of May. The agreement was with Victoria, New South Wales, South Australia, Western Australia, and Tasmania. The contracting colonies guaranteed the company against one-half of a possible loss, and the company risked the other half. The arrangement was for one year only, but could, and would be, extended if found to work satisfactorily, so that the continuance of the reduced rates depended upon the telegraphic public giving the telegraph their hearty support, and making it a success. It had been hoped that Queensland and New Zealand would take part in the experiment, but they had declined, and the tariff to those colonies would therefore remained unchanged. Since the report had been issued, an agreement had been formally concluded between the company and the Indo-European Telegraph Department, by which the guarantee and risk were shared between the parties according to their respective interests in Australian traffic. The maximum liability of the company, if there were no increase of traffic, would be £131,810, of which the colonies' share would be one half, £65,905, the Extension company's proportion £42,500, and the balance, £23,405, would be divided between the Eastern Telegraph Company and the Indo-European Telegraph Department. Allowing for a 25 per cent. increase of traffic, the Extension Company's liability would be £34,000; a 50 per cent. increase would reduce it to £25,000; a 75 per cent to £17,000, and 100 per cent. to £8,000. Since the close of the year the Telegraph Construction and Maintenance Company had successfully completed their contract with the company for the Madras-Penang cable (which was 1,388 nautical miles in length), and the Eastern Company's new cable between Suez, Aden and Bombay was being laid, so that the service was now in a thoroughly efficient condition to meet all the requirements which might arise in connection with the reduced rates to Australia. £100,000 had been paid out of revenue towards the cost of the Madras-Penang cable, and it was proposed to pay the rest, £150,000, from the same fund, as opportunity offered. The present length of the company's system was 15,700 nautical miles of cable, and owing to the policy of renewing and duplicating lines out of revenue, instead of capital, these cables now stood in their books at a low figure. The keeping down of capital and paying as much as possible out of income was the real root and foundation of success in submarine telegraphy. An additional reason why the reduction of rates should be a success was that in Australia every man was inspired with the ideas of becoming a merchant, so that while men who now spent a thousand pounds a year on telegrams would continue to spend as much and send more telegrams, a class would also be brought in who hitherto could not afford to use the telegraph. Three years ago they had been called on to make a reduction in their tariff, involving a loss of £65,000, and had recouped themselves in two years. Their present reduction would recoup them in a short time, and if successful would be the beginning of a new era in submarine telegraphy. He must express regret that Queensland and New Zealand had stood aloof. When, however, they saw it was to their own interests they would perhaps join the guarantee. They continued to be on very friendly relations with the Great Northern Company. Sir John concluded by moving the adoption of accounts and report.

This was carried unanimously.

The retiring directors and the auditors were then re-elected, and a vote of thanks to chairman and directors concluded the meeting.

South of England Telephone Company.

A meeting of the preference shareholders of the South of England Telephone Company was held at Winchester House on Monday last, to hear a statement from Mr. T. A. Welton, the official liquidator of the company. There was a very small attendance.

Mr. T. A. **Welton** said that meeting had been called in a great measure that preference shareholders might attend and ask questions regarding the debenture stock they had the option of receiving in exchange for their shares. Of the whole amount—£70,000—to be issued, preference shareholders had intimated to him that they wished to receive stock for £46,096, or nearly two-thirds. The balance he very probably could dispose of above par. He had brought with him the prospectus of a recent issue of £340,000, which showed an important margin of £350,000, to which the present £70,000 would be an addition and which might be increased by further additions till it was equal to not exceeding one-half of the share capital of the National Telephone Company. This £350,000 required an income of £15,750, and with the £70,000 added, it would require an income somewhat larger. The net revenue for 1890 was £185,000, out of which large sum the interest—a little over £20,000—would be paid. The most powerful argument he could adduce was, that various able financiers were preferring the debentures to cash. Mr. Morrison, for instance, who was known not only to be very wealthy, but an exceedingly shrewd man, had taken his issue of over 7,000 debenture shares. In issuing the debentures in this manner his object had been to prevent the necessity being thrown upon him of realising them all at once in the market, which might have depressed their value. The debenture stock was not quoted on the Stock Exchange, but would be shortly.

In reply to a question, Mr. T. A. Welton said the stock which was at present quoted stood at 103. He quoted a few more cases of shareholders who were exchanging for debentures and added that those who did not apply within a very few days would be paid in cash.

This concluded the meeting.

Reuter's Telegram Company, Limited.—The report of the directors states that the net profits for the year ending December 31st last, after payment of directors' remuneration, current expenses, and deducting rebate on unexpired subscriptions, amount to £4,594 7s., including £113 4s. 6d. brought forward from the last account. An interim dividend of 4s. per share was paid in October last, and the directors now recommend a further dividend of 4s. per share, making a total distribution for the year of 5 per cent. This will absorb £3,691 2s. 6d., and leave a balance of £903 4s. 6d. to be carried forward.

The West India and Panama Telegraph Company, Limited.—For the half-year ended December 31st last, the directors recommend dividends of 6s. per share on the first and second preference shares, and 9d. per share on the ordinary shares. A further payment of 28s. 6d. per share on the second preference shares is also to be made, being the balance of arrears of dividend.

The London Platino Brazilian Telegraph Company, Limited.—The board have decided that, after placing £6,000 to the reserve fund, the directors will recommend at the forthcoming meeting a dividend of 5s. per share, free of income tax, making with the interim dividend paid in November, a distribution of £4½ per cent. per annum for the year 1890.

The West Coast of America Telegraph Company, Limited.—The offices of the above company have been removed to 120, Cannon Street, London, E.C.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £5,750.

The City and South London Railway Company. Gross receipts for the week ended April 19th, £816; aggregate receipts for half year £11,729.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 17th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,640.

The West India and Panama Telegraph Company. The receipts for the half month ended April 15th, 1891, show an increase of £21 as compared with the corresponding period of 1890.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (April 16).	Closing Quotation. (April 23.)	Business done during week ending April 23, 1891.	
					Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	100	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	46½— 47½	47 – 48	47½	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84½— 85½	85½	85
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	11⅝	11¼
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11½— 12	11$\frac{13}{16}$	11½
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906	100	103 —107	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2¼— 2½	2⅜	...
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	5½— 6½	5½— 6½	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	108 —110	108 —110	108⅞	108½
224,850	Consolidated Telephone Construction and Maintenance, Limited	14/-	$\frac{7}{16}$— $\frac{9}{16}$	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4½— 5½	4½— 5½	5¼	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	11¼	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17¼	...
12,931	Direct Spanish Telegraph, Limited, (£4 only paid)	5	3¾— 4¼	3¾— 4¼	4	3⅞
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	9⅝	10$\frac{5}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜xd	14⅛— 14⅜xd	14$\frac{7}{16}$	14$\frac{3}{16}$
70,000	Do. 6 p. c. Preference	10	15¼— 15¾xd	15¼— 15¾xd	15½	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	107¼	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	109½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14¾— 15¼	14¾— 15¼	15¼	15
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	104½	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400	100	104 —107	104 —107	104¼	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	107¼	106
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	103½	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	100¼	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 6½	5 — 6	5⅝	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	1$\frac{7}{16}$	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000	2	2¾— 3¼	2¾— 3¼	3	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1½	1 — 1½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 (£4 only paid)	5	3 — 4	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅛— 9⅜xd	9⅛— 9⅜xd	9⅜	9$\frac{3}{16}$
180,042	Do. do. 6 p. c. Preference	10	14¾— 15 xd	14¾— 15	15	14$\frac{15}{16}$
150,000	Great Northern Tel. Company of Copenhagen	10	17½— 18	17½— 18	17¾	17½
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883)	100	103 —106	104 —107	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000	10	10½— 11½	10 — 11	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited	10	18½— 19½	18½— 19½	19$\frac{1}{16}$	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42¾	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105—108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¾— 9¼	9 — 9½	9⅜	9
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4¼— 4½	4¼— 4½	4½	4$\frac{7}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	13¼	13
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	9 — 9½	8¾— 9¼	9	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ¼	⅛— ¼	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3 — 3½	3 — 3½	...	...
3,381	Submarine Cables Trust	Cert.	113 —118	113 —118	...	...
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	4¾— 5¼	4¾— 5¼	4$\frac{15}{16}$	4⅞
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46¾	45½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	104	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	99¼	98
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½— 3½	3⅛	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902	100	92 — 97	92 — 97	...	...
64,174	Western and Brazilian Telegraph, Limited	15	12 — 12½	12 — 12½	12⅜	12⅛
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7¼	6¾— 7¼	7	6$\frac{15}{16}$
27,873	Do. do. do. 5 p. c. Deferred	7½	5¼— 5¾	5¼— 5¾	5$\frac{9}{16}$	5½
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 —106	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	104	...
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	3⅛— 3⅜	3⅜	2¾
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½— 12	11½— 12	12	11¾
4,669	Do. do. do. 6 p. c. 2nd Preference	10	11½— 12½	11½— 12½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100—104	100 —104	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	4⅞— 5⅛	4⅞— 5⅛	5⅛	5$\frac{1}{16}$

* Subject to Founders' Shares.

Latest Procurable Quotations of Securities not Officially Quoted.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 27—30.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅛—2⅜.—Manchester Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—St. James's and Pall Mall Electric Light £5, 6—6¼.—St. James's and Pall Mall, 7 per cent. pref., ⅝ to ⅞ prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2—2½.—Preference, fully paid 3⅞—4⅜.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1.

Bank Rate of Discount.—3½ per cent. (16th April, 1891).

PROCEEDINGS OF SOCIETIES.

Royal Society, April 9th.

THE MEASUREMENT OF THE POWER SUPPLIED BY ANY ELECTRIC CURRENT TO ANY CIRCUIT.

By Prof. AYRTON, F.R.S., and W. E. SUMPNER, D.Sc.

I.—During the meeting of the Electrical Congress in Paris in 1881, one of us* devised a method of using an electrometer for measuring the power given to any circuit by any current. This method is the only electrical one hitherto published, the accuracy of which does not depend on assumptions either as regards the character of the current variations or as regards the nature of the circuit the power given to some part of which we desire to measure.

In view then of the present wide use of alternating currents for industrial purposes, it might have been expected that this electrometer method of measuring the power given by any intermittent or alternating current to an inductive circuit would have been extensively employed. Unfortunately, however, as pointed out by one of us in conjunction with Prof. Perry (Journal of Society of Telegraph Engineers and Electricians, vol. xvii., 1888), the use of this method is restricted by the fact that Sir W. Thomson's quadrant electrometers do not generally obey the mathematical law given for these instruments in text-books,† as it was supposed they did when this electrometer method of measuring power was first suggested. And hence the main result that has, up to the present time, followed from the publication of this method has been the stimulation of inventive minds to devise forms of electrometers in which the text-book law is strictly fulfilled.

In 1888, Mr. Blakesley published a very ingenious method for measuring the power supplied by alternating currents to the primary coil of a transformer, by the use of three dynamometers. The proof originally given was geometrical, and was based on several assumptions, amongst others that the currents and magnetic fluxes varied with the time according to a simple sine law. An analytical proof has recently been given (meeting of Physical Society, February 27th, 1891) by one of us, in conjunction with Mr. Taylor, showing that the method gives equally good results however the currents and magnetic fluxes vary, but there still remains a serious objection to the method, as it is assumed that there is no magnetic leakage in the transformer, or, in other words, every line of force is supposed to thread each convolution of both primary and secondary coils. Further the method cannot be used with a single circuit as the coils of one of the dynamometers must be placed in different circuits.

The employment of an electro-magnetic wattmeter for the measurement of power is well known, but errors are introduced when alternating currents are used, owing to the self-induction of the fine wire coil. Several investigators have considered the magnitude of this error, and have suggested various devices for reducing it to a minimum.

II.—Several months ago, however, while working at alternate-current interference, we noticed that it was possible to employ an extremely simple method for measuring the power supplied by *any* current to *any* circuit. This method, which has since been in regular use in the laboratories of the Central Institution, is quite independent of any assumptions as to the nature of the current, or of the circuit, the power given to which it is desired to measure, and it has the further great advantage that the only measuring instrument required is the ordinary alternate-current voltmeter of commerce.

In series with the circuit *a b* (fig 1), the power given to which we desire to measure, connect a non-inductive resistance *b c* of *r* ohms.

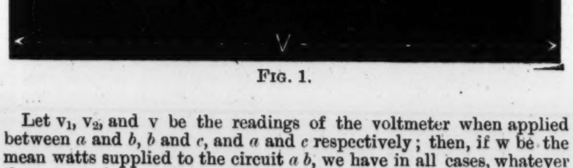


FIG. 1.

Let V_1, V_2, and V be the readings of the voltmeter when applied between *a* and *b*, *b* and *c*, and *a* and *c* respectively; then, if W be the mean watts supplied to the circuit *a b*, we have in all cases, whatever the nature of the current, or of the circuit *a b*—

$$W = \frac{1}{2r}\left(V^2 - V_1^2 - V_2^2\right) \qquad (1)$$

For, let v_1, v_2, and v be the instantaneous values of the P.D. between *a* and *b*, *b* and *c*, and *a* and *c* at some moment *t*, then

$$v = v_1 + v_2 \qquad (2)$$

If *a* be the current in ampères flowing through the circuit at time *t*, then $a\,v_1$ equals the watts *w* given to *a b* at that time. But

$$a = \frac{v_2}{r},$$

since the resistance *b c* is non-inductive;

$$\because\ w = \frac{v_1 v_2}{r}.$$

Then, squaring (2) we have—

$$v^2 = v_1 + 2v_1 v_2 + v_2^2;$$

$$\therefore\ w = \frac{1}{2r}\left(v^2 - v_1^2 - v_2^2\right).$$

As this equation is true at every moment, it must also be true for the mean values of w, v^2, v_1^2, and v_2^2.

So that

$$\int_0^T w\,dt = \frac{1}{2r}\left(\int_0^T v^2\,dt - \int_0^T v_1^2\,dt - \int_0^T v_2^2\,dt\right),$$

and

$$W = \frac{1}{2r}\left(V^2 - V_1^2 - V_2^2\right),$$

which is the equation given above.

If the resistance of *b c* be not known, or if there be any fear that it may be changed by the passage of the current, then an ammeter (an alternate current ammeter, of course, if alternate currents be employed) can be inserted in the circuit. Let the reading of this ammeter, which represents the square root of the mean square of the current be A, then, for *r* in (I) we may substitute V_2/A, or

$$W = \frac{A}{2\,V_2}\left(V^2 - V_1^2 - V_2^2\right) \qquad (3)$$

When employing this last formula, the non-inductive resistance, *b*, *c*, may be that offered by incandescent lamps, since there is no objection to the resistance varying with different mean strengths of the current employed.

This voltmeter method of measuring power was arrived at quite independently of the electrometer method referred to above, but an examination of the electrometer method shows that it is practically equivalent to simultaneous measurements of three P.Ds.

An analysis of the equation (I) shows that the value of the non-inductive resistance, *r*, which it is best to adopt in order to reduce to a minimum the error in W arising from errors in the voltmeter readings, is such that the potentials, V_1 and V_2 are equal to each other. It can also be shown that the percentage error in estimating the power, W, due to errors in the voltmeter measurements arising either from faulty graduation of the scale, or from inaccurate readings, is from four to five times the percentage error of a single reading of the voltmeter.

As all instruments that are graduated for measuring the square root of the mean square of an alternating P.D., such as a hot wire voltmeter, an electrostatic voltmeter, &c., really measure the mean square and not the square root of the mean square directly, it would be better, if such an instrument were to be employed for the method of measuring power described in this paper, that it should be graduated in mean squares of P.Ds. and not in the square roots of the mean squares. In that case the probable percentage error in the measurement of power by the method would be from 2 to 2·5 times the error in the measurement of each of the P.Ds.

It is, of course, clear that these errors to which we have been referring are not errors in any way essential to the method proposed for measuring power, since by the employment of an accurately graduated voltmeter, by exercising care in taking the readings, and, if necessary, by repeating the measurements two or three times and taking the means of the observations, the power can be measured to any degree of accuracy desired.

As in practical cases the sum of the two potentials V_1 and V_2, will not often be much in excess of V, we may conveniently express the true power, W, in the following way.

If A is the current in *a b* (fig. 1) as read by an alternating current ammeter, the apparent power absorbed by *a b* is

$$V_1 . A.$$

The true power W, when V_2 is made equal to V_1, can be shown to be

$$W = \left(1 - 2y + \frac{y^2}{2}\right) V_1 A,$$

where

$$y = \frac{V_1 + V_2 - V}{V_1},$$

or as *y* is usually a small number,

$$W = (1 - 2y)\, V_1 A.$$

Thus the error made in assuming that $V_1 A$ represents the true power is 8 per cent. if $(V_1 + V_2 - V)$ is 4 per cent. of V_1, also if, due to unsteadiness of the currents, or to error in the voltmeter readings, the value of $(V_1 + V_2 - V)$ is uncertain to the extent of 1 per cent. of V_1, the uncertainty in estimating W is twice this, or 2 per cent.

III.—The method we have just described is well adapted for measuring the power supplied to an alternating current arc lamp, and is, moreover, likely to be of service in investigating the phenomena of the alternating current arc. Three of our senior students, Messrs. Kolkhorst, Thornton and Weekes, have made a number of experiments on arc lamps by the use of this method, and from their experiments it would appear that the quality of the carbon employed affects materially the difference in phase between the currents passing through the arc and the P.D. between the carbons. If the arc be quite steady and only give out the rhythmic hum that accompanies a well-formed arc, such as can be obtained with cored carbons of good quality, the arc appears to act practically as a simple resistance, but if the arc be maintained between uncored carbons of poor quality, and be hissing, there is considerable difference in phase between the current and the P.D. between the terminals; further, the experiments show that the current is very far from being a sine function of the time, although produced by a dynamo whose E.M.F. normally follows a harmonic law.

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* This method was simultaneously arrived at independently by Prof. Fitzgerald.

† We may mention that an investigation on quadrant electrometers has been going on from time to time at the Central Institution for the last five years, and we had hoped to have communicated the complete report long before this to the Royal Society.

In addition to the difference of phase of P.D. and current that may be produced in the arc itself, there is the electro-magnet to be considered, by which the distance between the carbons is usually regulated in arc lamps. This electro-magnet will introduce lag between the P.D. at the terminals of the lamp and the current passing through the electro-magnet and the arc in series; and hence, even although the arc be perfectly steady, we find, even in the case of a Brush lamp especially intended for alternate currents, that the true power supplied to the electro-magnet and arc is 20 per cent. less than the product of the readings of the ammeter and the voltmeter attached to the lamp terminals, and which gives the square root of the mean product of the squares of the current and P.D.

If, however, the arc be between common carbons and be hissing, the difference, we find is much greater. With cored carbons this Brush lamp requires a P.D. of about 35 volts to be maintained between its terminals, but if these cored carbons be replaced by common carbons and the arc be hissing, the P.D. between the terminals of the lamp at once rises to 45 or even 50 volts, although the current passing through the lamp and the amount of light given out remain practically as before. And then we find that the true power supplied to the lamp may be only one-half of the square root of the mean product of the squares of the current and P.D., so that the readings of ammeter and voltmeter alone make the apparent power twice as great as the true power.

For the purpose of easily estimating the ratio of the true to the apparent power supplied, formula (3) may be thus written

$$W = A\,V_1 \left\{ 1 - \frac{(V_1 + V_2 - V)\,(V_1 + V_2 + V)}{2\,V_1\,V_2} \right\} \qquad (4)$$

from which we see that the expression in the brackets represents the ratio of the true to the apparent power supplied to the lamp or other circuit, *a*, *b* (fig. 1). Hence the percentage error made in assuming that the power supplied to any circuit was the product of the ammeter and voltmeter readings would be in all cases, whatever the nature of the current or of the circuit,

$$100\,\frac{(V_1 + V_2 - V)\,(V_1 + V_2 + V)}{2\,V_1\,V_2} \qquad (5)$$

The following are samples of the results obtained with a hand-regulated lamp, there being no electro-magnet at all in series with the arc (fig. 2). The carbons were not cored, and the arc was hissing. The frequency was maintained at 200 periods per second.

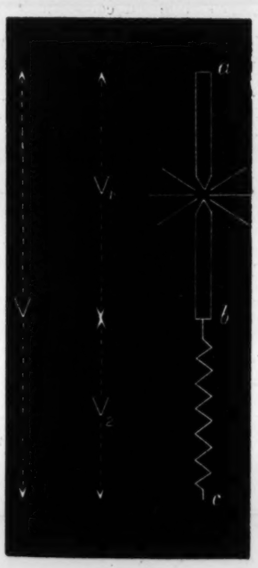

FIG. 2.

TABLE I.

Square root of mean square				Percentage error in estimating power formula (5).
Of P.D. in volts between			Of current in ampères.	
a and *b*. V_1.	*b* and *c*. V_2.	*a* and *c*. V.	A.	
55·0	60·0	108·0	12·3	24·0
45·4	75·4	107·3	11·8	45·8

For the purpose of obtaining an idea of ϕ, the angle of phase difference produced by the hissing arc, between the current and the P.D., we may assume that the P.D. and current are sine functions of the time; then, as may be easily proved,

$$\cos\phi = \frac{V^2 - V_1^2 - V_2^2}{2\,V_1\,V_2} \qquad (6)$$

and the values of ϕ for the two tests given above come out as 40° 20′ and 57° 10′. It will, of course, be observed that this assumption of a harmonic law for the P.D. and current for the purpose of obtaining some idea of the value of ϕ, in no way affects the generality of the method for the measurement of the power, since this is based on no such assumption.

The following are samples of the results obtained with a Brush alternate current lamp regulated by an electro-magnet (Fig. 3), the carbons not being cored, and the arc hissing. The frequency was maintained at 200 periods per second.

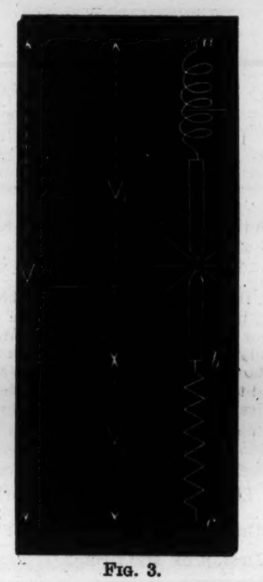

FIG. 3.

TABLE II.

Square root of the mean square				Percentage error in estimating power formula (5).	Lag between current and P.D.
Of P.D. in volts between			Of current in ampères.		
a and *b*. V_1.	*b* and *c*. V_2.	*a* and *c*. V.			ϕ.
64·8	58·0	108·4	13·0	44·0	56° 0′
59·8	64·2	107·4	12·0	50·5	60 20
55·0	67·3	107·4	10·6	47·0	58 30

The experiments already described tell us that a hissing arc may cause a considerable phase difference between the P.D. and the current, but they do not enable us to decide whether such an arc causes the current to lag behind the P.D., or to lead in front of it. To decide this point—that is, to decide whether a hissing arc acts like an inductive coil, or a condenser—a variety of experiments were

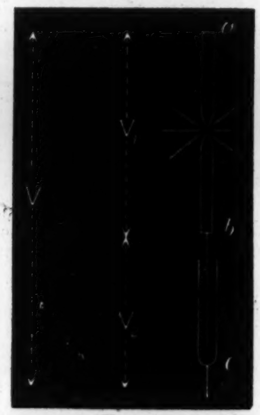

FIG. 4.

made by putting induction or capacity in series with the arc. The following gives the result of one such experiment:—In series with a hand-regulated lamp (and, therefore, containing no electro-magnet), was placed a condenser of 89 microfarads (fig. 4). Uncored carbons were used, and they were adjusted so that the arc was very short at first; the carbons were then not touched, and, as they burnt away, the arc grew longer and longer until it finally went out. The frequency was maintained at 200 periods per second.

TABLE III.

E.M.F. of dynamo in volts.	Square root of mean square				Sum of $V_1 + V_2$.	Lag between current and P.D.
	Of P.D. in volts between			Of current in ampères.		
	a and *b*. V_1.	*b* and *c*. V_2.	*a* and *c*. V.	A.		ϕ.
59	35·4	89·0	72·3	12·0	124·4	129°
	38·0	92·0	73·3	12·5	130·0	133
	51·2	104·5	74·3	14·0	155·7	135
	69·2	86·5	67·5	13·4	155·7	131

Comparing V with the E.M.F. of the dynamo, we see that the arc and the condenser together acted as a condenser on the whole; but, comparing V with $V_1 + V_2$, we see that the arc acted as an induction and not as a capacity.

Calculations from the measurements made on the assumptions that the arc acts like an induction coil, and that the current follows a simple sine law, show that the inductance of the arc itself is as great as that of the regulating electro-magnet used in the lamp. When, however, the inductances of the arc and electro-magnet in series is observed, it is found to be less than the sum of the two inductances. This shows conclusively that the current does not vary according to a simple sine law.

Institution of Electrical Engineers.—April 16th, 1891.

CONTINUATION OF DISCUSSION ON MR. ESSON'S PAPER, "NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS."

(*Authorised Abstract.*)

MR. F. V. ANDERSEN supplemented his former remarks by saying that in considering the question of sparklessness in dynamos account should be taken of the lead of the brushes, for very large currents could be collected without much sparking, if the lead was not limited to a small angle. Mr. Esson's formula for the limiting currents was doubtless true if the brushes be at the polar tips; this, however, meant a considerable lead, and a change of, say, 10 per cent. in the load would necessitate the readjustment of the brushes. Now, for central station work it was desirable that machines should have a very small lead, and this could be obtained by having long powerful fields. Referring to the cost of multipolar machines, he said that their chief characteristics were short fields and shallow armature cores. There was, however, no difficulty in making two-pole machines with short fields, provided large lead was permissible, or the maximum load decreased as the limbs were shortened. He therefore considered that there was no gain in splitting up the constructive material to form multipolar fields.

Mr. **HOUSMAN** greatly appreciated Mr. Esson's term, "volume of current," but thought the fact that it meant twice the ampère-turns should have been made more clear. The whole of the author's argument in favour of multipolar machines, he said, depended on the length of the air-space necessary to prevent sparking being generally greater than that required for the copper. As regards the relations of "volume of current" and output to the diameter of armature, he thought that for equal rise of temperature the "volume" v was proportional to diameter to the power three-halves, $d^{\frac{3}{2}}$; hence the output for the same circumferential velocity would vary as $d^{\frac{5}{2}}$; under the same conditions of circumferential speed and induction the loss by hysteresis varies as d^2, and consequently the rise of temperature due to this loss was the same for all sizes of armature. Foucault current losses, however, varied as d^2, and, in general, these were much greater than those due to hysteresis. In practice, he had observed that the maximum safe output for a given armature was reached when the sum of the hysteresis and Foucault current losses was about equal to the losses in the conductors. The rapidity with which heating due to Foucault currents increased with the diameter prevented the output varying in so great a ratio as $d^{\frac{5}{2}}$; and, as a rule, it increased in a ratio somewhere between d^2 and $d^{\frac{5}{2}}$. Referring to the limiting non-sparking load, he said that Mr. Swinburne's hypothesis (on which the author bases his arguments), which says that the self-induction of an armature coil is small, and therefore only a weak field is required to effect sparkless reversal, was not justified. The coefficient of self-induction of an armature section, as measured by a ballistic galvanometer, placed in circuit with a coil wound close to a disconnected section he found to be very considerable, and by passing various currents through the latter the variation of the coefficient with armature current had been ascertained. From the coefficients so determined he had calculated the strengths of field necessary to effect reversal, and by measuring the field found the armature had determined the non-sparking lead for various currents. These calculated values agreed fairly closely with those found by actual trial; and in the case of a small air space dynamo a field of 3,000 C.G.S. units was necessary to produce sparkless commutation, the maximum field being 7,000. To further investigate how far Mr. Swinburne's hypothesis was correct, he had run a dynamo at half load with different brushes, the first set covering one commutator segment and the next bearing on only half a segment. In the latter case the lead required was much greater than in the former. If the hypothesis was correct a very small change of lead should double the field, but in practice the additional lead was considerable. The difficulty of variable lead could, as was well known, be got over by using "commutating magnets" or "reversing pole pieces." Those shown in Mr. Swinburne's paper on "Armature Reactions" were quite inadequate as regards size, for in practice they had to be much more substantial. As a rule, the number of series turns on these "commutating magnets" was about ·75 times the *effective* armature turns for single magnet machines, and for double magnet machines 1·25 times the effective turns. On the question of efficiency, he said that multipolar machines could not compete with two-pole ones, for the weight of iron was not diminished in so great a ratio as the increase in number of poles, and hence both the hysteresis and Foucault current losses for a given output were greater in multipolar machines. Neither would the magnets be so light as stated in the paper, and the economy obtained by having all the winding on one magnetic circuit was all in favour of the two-pole type. A difficulty, however, was met with in large two-pole machines, owing to the energy stored up in a single section of a large machine when a strong current is passing being very great, and this caused considerable trouble, but he thought it might be overcome by subdividing the winding.

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Mr. **HOUSMAN** explained his method of analysing Foucault current and hysteresis losses in dynamo armatures by running them as separately excited motors without load, and observing the volts and ampères required at different speeds. The results when plotted give an inclined straight line (A, B, fig. B), from the position of which the Foucault losses may be determined. Friction and hysteresis are not separated in the initial diagram, but the former may be determined by other experiments. The results so obtained with various exciting currents show that a certain excitation gives a minimum total loss.

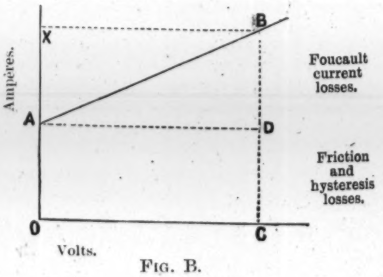

FIG. B.

Mr. A. T. **SNELL** thought the term "volume of current" would be very useful as a name for a quantity often used by designers. His own experience as regards "volume" and diameter agreed with the formulæ given by the author, and the ratio of the constants, ·048 and ·072 in formulæ (5) and (6), for the output of cylinder and drum armatures were in the same ratio as the coefficients ·01 and ·015 given by himself about two years ago. He did not agree with Mr. Esson that the output of an armature was independent of the number of poles, for he found that the output could be considerably increased by using four poles instead of two. This he illustrated by the following table, which expresses results obtained from two machines in which the air gaps, speed, and heating were about the same :—

Machine.	Diameter of Armature.	Volume of Current.	Volts.	Ampères.	Watts.
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Four-pole. .	60 cms.	14,700	250	300	75,000

The advantages of four-pole machines generally, he considered due to the air-gaps, magnets and cross-magnetising forces being small, whilst the peripheral velocity for a given speed of the shaft could be large. This last was of great importance in direct-driven machines. Their disadvantage was that they usually had a large magnetic density in the iron and air space, but the latter could be obviated by spreading out the polar extremities.

Mr. Miller remarked that in the case of dynamos for the transmission of power, the design was influenced by the voltage of the machine, for there was a limit to the difference of potential that could safely and conveniently be used between commutator sections of ordinary construction. For example, a machine to give 2,000 ampères and 50 volts could best be made multipolar, but not so one for 2,000 volts and 50 ampères. In the latter case, it would not be advisable to concentrate the volts in a fourth or sixth of the circumference. On the question of the utility or otherwise of cross-connections in multipolar machines between sections which, theoretically, should be at the same potential, he said that in practice the evil consequences of various inequalities were minimised thereby. In his opinion, based on experience, the extra expense of cross-connections was well worth incurring, for they produced a distinct diminution in sparking. He also said that Mr. Esson had not even mentioned unipolar machines, presumably because he considered they were worthless. This, he thought, was a mistake. One of the chief faults usually attributed to them, viz., that there was a great fall of volts between no load and full load, did not exist if they were properly designed.

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5,641. "The improvement of electric arc lamps.". A. E. Angold. Dated April 1st.

5,656. "Improvements in and relating to electric lamps or lighting apparatus." A. L. Shepard. Dated April 1st.

5,679. "Improvements in or connected with telephones." R. Steenberg. Dated April 2nd.

5,690. "Improvements in and connected with electric batteries." H. C. Bull. Dated April 2nd.

5,711. "Improvements in the manufacture of seamless tubes or conduits for electrical and other purposes, and in the apparatus employed therein." J. R. Thame. Dated April 2nd.

5,712. "Improvements in insulating electrical conductors." S. Pitt. (Communicated by E C. Davidson, United States.) Dated April 2nd.

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5,739. "Improvements in interlocking railway signals, points, and block telegraph intruments." G. W. Beynon. Dated April 3rd.

5,766. "Improvements in electrical apparatus for use as an electric current meter or as an electro-motor." G. J. Philpott and R. Hammond. Dated April 3rd.

5,780. "An improved safety device or cut-out for the protection of electric circuits, and of apparatus connected therewith." J. M. McMahan. Dated April 3rd.

5,790. "Improvements in incandescent electric lamps." E. Boehm and E. Bailey. Dated April 3rd.

5,794. "Improvements in the application of light, heat, and motive power obtained from electrical circuits to the purposes of advertisement." A. R. Upward and J. H. Macfarren. Dated April 4th.

5,802. "Improvements in holders for incandescent electric lamps.' W. McGeoch, Jun., and A. J. McGeoch. Dated April 4th.

5,824. "Improvements in the manufacture of filaments for electric glow lamps." J. Pitkin. Dated April 4th.

5,834. "Improvements in electrical measuring instruments." G. Wilkinson. Dated April 4th.

5,835. "Improvements in or relating to electrical measuring or indicating instruments." A. D. Jones. Dated April 4th.

5,869. "Improvements in indicators for electric bells, or for the passage of electric currents." G. Scarlett. Dated April 6th.

5,912. "Improvements in the transmission of electricity to portable cranes and other machinery, telpher lines and the like." W. D. Sandwell. Dated April 6th.

5,918. "Improvements in electric batteries." H. I. Harris and W. H. Power. Dated April 6th.

5,947. "Method of and means for renewing or repairing the filaments of incandescent electric lamps." H. Chapman. Dated April 7th.

5,953. "Improvements in and relating to voltaic batteries." W. A. Byron and E. George. Dated April 7th.

5,963. "An electric 'hooter' or loud sound producing apparatus." H. A. C. Saunders and A. C. Brown. Dated April 7th. (*Complete.*)

5,972. "Improvements in electric storage batteries." W. Sillery. Dated April 7th.

5,983. "Improvements in or connected with means or apparatus employed in electrolysis." E. A. Le Sueur. Dated April 7th. (*Complete.*)

5,989. "An improved means of wiring brackets, pendants, electroliers, and the like for electric lighting." E. W. Lancaster. Dated April 7th.

5,993. "Improvements in the electric cup." F. E. S. D'Odiardi. Dated April 7th.

5,994. "Improvements in electro-inhalers." F. E. S. D'Odiardi. Dated April 7th.

5,995. "Improvements in liquid electrodes." F. E. S. D'Odiardi. Dated April 7th.

5,996. "Improvements in magneto-voltaic and static electrodes." F. E. S. D'Odiardi. Dated April 7th.

5,997. "Improvements in electric atomizers." F. E. S. D'Odiardi. Dated April 7th.

6,003. "Terminals for cables of electrical conductors." J. C. Reilly. Dated April 7th. (*Complete.*)

6,007. "Improvements in handles or taps for electrical switches." E. W. Lancaster. Dated April 7th.

6,011. Improvements in ceiling roses for electric lighting." A. P. Lundberg. Dated April 8th.

6,012. "Improvements in switches for electric lighting." A. P. Lundberg. Dated April 8th.

6,029. "Improvements in electro-depositing copper, brass, and bronze, parts of which improvements are also applicable to other purposes." W. H. Walenn and I. A. Timmis. Dated April 8th.

6,030. "Improvements in electro-depositing copper, brass, or bronze." W. H. Walenn and I. A. Timmis. Dated April 8th.

6,048. "Improvements in electric power apparatus." G. North. Dated April 8th

6,072. "Improvements in electro-heating apparatus." C. E. Carpenter. Dated April 8th. [Date applied for under Patents Act, 1883, Sec. 103, 27th September, 1890, being date of application in United States.] (*Complete.*)

6,125. "Improvements in electrical apparatus for soldering, boiling and heating." J. J. Ritter. Dated April 9th. (*Complete.*)

6,194. "Improvements in electromotors for alternating currents." J. A. Kingdon. Dated April 11th.

made by putting induction or capacity in series with the arc. The following gives the result of one such experiment:—In series with a hand-regulated lamp (and, therefore, containing no electro-magnet), was placed a condenser of 89 microfarads (fig. 4). Uncored carbons were used, and they were adjusted so that the arc was very short at first; the carbons were then not touched, and, as they burnt away, the arc grew longer and longer until it finally went out. The frequency was maintained at 200 periods per second.

TABLE III.

E.M.F. of dynamo in volts.	Square root of mean square				Sum of $V_1 + V_2$.	Lag between current and P.D.
	Of P.D. in volts between			Of current in ampères.		
	a and *b*. V_1.	*b* and *c*. V_2.	*a* and *c*. V.	A.		ϕ.
59	35·4	89·0	72·3	12·0	124·4	129°
	38·0	92·0	73·3	12·5	130·0	133
	51·2	104·5	74·3	14·0	155·7	135
	69·2	86·5	67·5	13·4	155·7	131

Comparing v with the E.M.F. of the dynamo, we see that the arc and the condenser together acted as a condenser on the whole; but, comparing v with $v_1 + v_2$, we see that the arc acted as an induction and not as a capacity.

Calculations from the measurements made on the assumptions that the arc acts like an induction coil, and that the current follows a simple sine law, show that the inductance of the arc itself is as great as that of the regulating electro-magnet used in the lamp. When, however, the inductances of the arc and electro-magnet in series is observed, it is found to be less than the sum of the two inductances. This shows conclusively that the current does not vary according to a simple sine law.

Institution of Electrical Engineers.—April 16th, 1891.

CONTINUATION OF DISCUSSION ON MR. ESSON'S PAPER, "NOTES ON THE DESIGN OF MULTIPOLAR DYNAMOS."

(*Authorised Abstract.*)

MR. F. V. ANDERSEN supplemented his former remarks by saying that in considering the question of sparklessness in dynamos account should be taken of the lead of the brushes, for very large currents could be collected without much sparking, if the lead was not limited to a small angle. Mr. Esson's formula for the limiting currents was doubtless true if the brushes be at the polar tips; this, however, meant a considerable lead, and a change of, say, 10 per cent. in the load would necessitate the readjustment of the brushes. Now, for central station work it was desirable that machines should have a very small lead, and this could be obtained by having long powerful fields. Referring to the cost of multipolar machines, he said that their chief characteristics were short fields and shallow armature cores. There was, however, no difficulty in making two-pole machines with short fields, provided large lead was permissible, or the maximum load decreased as the limbs were shortened. He therefore considered that there was no gain in splitting up the constructive material to form multipolar fields.

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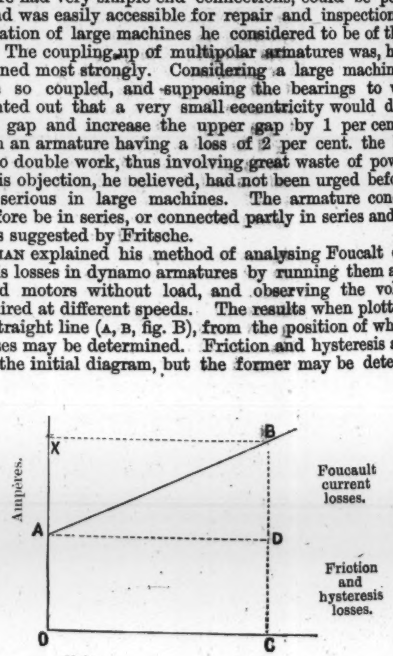

FIG. B.

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5,637. "Improvements in electric converters." R. W. Barker. (Communicated by M. G. Farmer, United States.) Dated April 1st.

5,638. "Improvements in electric batteries." W. A. Crowdus. Dated April 1st. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, 7th October, 1890, being date of application in United States.]

5,641. "The improvement of electric arc lamps.". A. E. Angold. Dated April 1st.

5,656. "Improvements in and relating to electric lamps or lighting apparatus." A. L. Shepard. Dated April 1st.

5,679. "Improvements in or connected with telephones." R. Steenberg. Dated April 2nd.

5,690. "Improvements in and connected with electric batteries." H. C. Bull. Dated April 2nd.

5,711. "Improvements in the manufacture of seamless tubes or conduits for electrical and other purposes, and in the apparatus employed therein." J. R. Thame. Dated April 2nd.

5,712. "Improvements in insulating electrical conductors." S. Pitt. (Communicated by E C. Davidson, United States.) Dated April 2nd.

5,713. "Improvements in insulating electrical conductors." S. Pitt. (Communicated by E. C. Davidson, United States.) Dated April 2nd.

5,714. "Improvements in insulating electrical conductors." S. Pitt. (Communicated by E. C. Davidson, United States.) Dated April 2nd.

5,715. "Improvements in insulating electrical conductors." S Pitt. (Communicated by E. C. Davidson, United States." Dated April 2nd.

5,739. "Improvements in interlocking railway signals, points, and block telegraph intruments." G. W. Beynon. Dated April 3rd.

5,766. "Improvements in electrical apparatus for use as an electric current meter or as an electro-motor." G. J. Philpott and R. Hammond. Dated April 3rd.

5,780. "An improved safety device or cut-out for the protection of electric circuits, and of apparatus connected therewith." J. M. McMahan. Dated April 3rd.

5,790. "Improvements in incandescent electric lamps." E. Boehm and E. Bailey. Dated April 3rd.

5,794. "Improvements in the application of light, heat, and motive power obtained from electrical circuits to the purposes of advertisement." A. R. Upward and J. H. Macfarren. Dated April 4th.

5,802. "Improvements in holders for incandescent electric lamps.' W. McGeoch, Jun., and A. J. McGeoch. Dated April 4th.

5,824. "Improvements in the manufacture of filaments for electric glow lamps." J. Pitkin. Dated April 4th.

5,834. "Improvements in electrical measuring instruments." G. Wilkinson. Dated April 4th.

5,835. "Improvements in or relating to electrical measuring or indicating instruments." A. D. Jones. Dated April 4th.

5,869. "Improvements in indicators for electric bells, or for the passage of electric currents." G. Scarlett. Dated April 6th.

5,912. "Improvements in the transmission of electricity to portable cranes and other machinery, telpher lines and the like." W. D. Sandwell. Dated April 6th.

5,918. "Improvements in electric batteries." H. I. Harris and W. H. Power. Dated April 6th.

5,947. "Method of and means for renewing or repairing the filaments of incandescent electric lamps." H. Chapman. Dated April 7th.

5,953. "Improvements in and relating to voltaic batteries." W. A. Byron and E. George. Dated April 7th.

5,963. "An electric 'hooter' or loud sound producing apparatus." H. A. C. Saunders and A. C. Brown. Dated April 7th. (*Complete.*)

5,972. "Improvements in electric storage batteries." W. Sillery. Dated April 7th.

5,983. "Improvements in or connected with means or apparatus employed in electrolysis." E. A. Le Sueur. Dated April 7th. (*Complete.*)

5,989. "An improved means of wiring brackets, pendants, electroliers, and the like for electric lighting." E. W. Lancaster. Dated April 7th.

5,993. "Improvements in the electric cup." F. E. S. D'Odiardi. Dated April 7th.

5,994. "Improvements in electro-inhalers." F. E. S. D'Odiardi. Dated April 7th.

5,995. "Improvements in liquid electrodes." F. E. S. D'Odiardi. Dated April 7th.

5,996. "Improvements in magneto-voltaic and static electrodes." F. E. S. D'Odiardi. Dated April 7th.

5,997. "Improvements in electric atomizers." F. E. S. D'Odiardi. Dated April 7th.

6,003. "Terminals for cables of electrical conductors." J. C. Reilly. Dated April 7th. (*Complete.*)

6,007. "Improvements in handles or taps for electrical switches." E. W. Lancaster. Dated April 7th.

6,011. Improvements in ceiling roses for electric lighting." A. P. Lundberg. Dated April 8th.

6,012. "Improvements in switches for electric lighting." A. P. Lundberg. Dated April 8th.

6,029. "Improvements in electro-depositing copper, brass, and bronze, parts of which improvements are also applicable to other purposes." W. H. Walenn and I. A. Timmis. Dated April 8th.

6,030. "Improvements in electro-depositing copper, brass, or bronze." W. H. Walenn and I. A. Timmis. Dated April 8th.

6,048. "Improvements in electric power apparatus." G. North. Dated April 8th

6,072. "Improvements in electro-heating apparatus." C. E. Carpenter. Dated April 8th. [Date applied for under Patents Act, 1883, Sec. 103, 27th September, 1890, being date of application in United States.] (*Complete.*)

6,125. "Improvements in electrical apparatus for soldering, boiling and heating." J. J. Ritter. Dated April 9th. (*Complete.*)

6,194. "Improvements in electromotors for alternating currents." J. A. Kingdon. Dated April 11th.

6,232. "Improvements in microphones for telephonic circuits, and in the induction coils thereof." E. Gwosdeff and A. Bunge. Dated April 11th.

6,243. "Improvements in galvanic batteries." S. M. L. Patz and R. Grebner. Dated April 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

4,000. "Improvements in electric regulators." H. Pieper, Fils. Dated March 14th. 8d. Claim:—The combination of an electro-magnet, an iron core so arranged relatively to the electro-magnet that the latter produces together with the core a magnetic field, and a coil of wire (field coil) placed on said core and connected to the magnetising coil of the electro-magnet, the field coil and the electro-magnet being movable relatively to each other in the direction of the axis of the said field coil, and the field coil having a length differing from that of the magnetic field, substantially as described.

10,122. "Improvements in and relating to heating apparatus for use on electric railways." M. W. Dewey. Dated January 27th. (Under International Convention.) 8d. Consists in the combination with a series electric railway, or a railway employing a constant or nearly constant current in the supply circuit of travelling vehicles, electric motors on said vehicles electrically connected to the supply circuit to propel said vehicles, electric heaters to heat said vehicles, and connected in the supply circuit in series, and means to regulate the current flowing through the heaters. Consists, further, and more specifically in the combination with an electric railway of a continuous line working conductor, a vehicle, an electric motor to propel said vehicle, electrical connections between said motor and working conductor, suitable means to create or locate electrical resistance or counter-electromotive force in said conductor between the connections an electric heater to heat said vehicle, suitable means for supplying current to the heater from the line conductor, and an automatic current regulator on the vehicle to control the current flowing through the heater independently of the motor.

12,997. "An improved electrical rock-drill, coal-digger, or earth-cutter." W. Blanch Brain, A. J. Arnot, and F. Baker. Dated August 19th. 6d. Consists essentially in combining an earth-boring auger with an electro-motor, by providing the latter with a comparatively large hollow spindle, through which a rod or spindle, secured to the auger, can pass freely longitudinally, and at the same time be caused to rotate therewith. This said hollow spindle has the commutator and armature secured to it in the ordinary manner. 1 claim.

18,576. "Improvements in apparatus for controlling electric currents." R. H. C. Nevile. Dated November 18th. 8d. Claims:—1. In an apparatus for controlling the flow of an electric current in one direction by means of an electro-magnet or electro-magnets and a movable arm, substantially as above described, the use of two wires connected in such a way that when the main circuit is closed, and the current flowing principally through the larger wire, the smaller wire will be short circuited by the larger wire, and have only a very minute fraction of the total current flowing through it. 2. The use, in conjunction with apparatus for the above purpose, of an electro-magnet or magnets of a horseshoe form between the poles of which the movable magnet vibrates. 3. The use, in conjunction with apparatus for the above purpose, of a bell or bells or any indicating apparatus, substantially as described, for the purpose of indicating the action or non-action of the apparatus. 4. The use of apparatus, substantially as above described, for preventing or reducing the flow of an electric current through an electric circuit in one direction.

18,625. "Improvements in and relating to apparatus for use in electric welding, forging, and other metal working operations." H. H. Lake. (Communicated from abroad by H. Lemp, of America.) Dated November 18th. 8d. Consists essentially in constructing the apparatus with a plurality of transformer secondaries arranged in parallel or in intersecting planes, and made to supply the current to the work or the work holding devices in parallel or multiple arc circuits. 8 claims.

18,631. "Improvements relating to the welding of metals by electricity." H. H. Lake. (Communicated from abroad by Prof. Elihu Thomson, of America.) Dated November 18th. 6d. Consists essentially in the repeated application of a heating electric current and of pressure alternately to the pieces to be welded. 1 claim.

19,057. "Improvements in electric arc lamps." W. P. Thompson. (A communication from abroad by R. H. Beach, of America.) Dated November 24th. 6d. Relates to improvements in electric arc lamps, in which the carbons are automatically advanced and consumed, its object being to secure an unvarying point of light at the tips of the carbons and an arc of unvarying length. 6 claims.

19,097. "Improvements in and in the method of manufacturing incandescent electric lamps and other exhausted receivers." A. M. Clark. (A communication from abroad by A. Bornholdt and J. Glatz, both of New York.) Dated November 25th. 6d. According to this invention, the neck or mouth of the bulb or vessel instead of being sealed as usual is closed by a stopper provided with a gravity valve opening outwards, so as to permit the creation of the vacuum within the vessel, and to hermetically close the same when exhausted. 3 claims.

19,162. "Improvements in methods of electric welding and metal working." M. W. Dewey. Dated November 25th. 8d. Consists in connecting the bar or blank with one terminal of an electric generator, embedding the portion of the bar or blank to be worked in a yielding bed of conducting material in connection with the other terminal, and passing a suitable heating current through the bar or blank, or a portion thereof, and the yielding bed. Consists, also, in connecting the bar or blank with one terminal of an electric generator, bringing an end or other portion of the bar or blank to be worked in contact with a pole of a magnet, passing a heating current through and between the bar or blank and the magnet, and then applying pressure or force to work the same while under the influence of the magnet. Consists further in connecting the bars or blanks to be welded together to one terminal of an electric generator, bringing the ends or other desired portions of the bars or blanks to be welded together in contact with a yielding bed of conducting material connected to the other terminal of the generator, placing the ends or parts to be welded together in contact with each other, and then applying force to unite the parts. 12 claims.

CORRESPONDENCE.

The Elmore Copper Companies.*

I note that you have made several mistakes in my letter published in your issue of the 17th, and should be glad if you would kindly correct them. It is surely bad enough to have you wilfully—as I fully believe—mis-quoting my patent specifications as you did on a former occasion, for the purpose no doubt of supporting your inconsistent argument, without now doing me the injury of not printing my letter as it was sent you, more particularly when one remembers your correspondence with Mr. C. H. W. Biggs as to proof reading.

To begin with, you have headed my letter "Elmore Copper Companies." You might better have headed it "Watt's System of Patent Making," or "What's Watt?"

On the tenth line counting from the bottom, in the second column, page 511, you use the term "Company erecting," which should be "Company wrecking."

On the last line of the fourth paragraph, in the first column, page 512, you print "When you *understood* to boom the Marchant engine," instead of "When you *undertook* to boom the Marchant engine."

And in the second line of the following paragraph you altered my meaning by printing "the utter *regard* for the truth," instead of "utter *disregard* for the truth displayed by him," besides other minor mistakes.

I note in your editorial remarks that you say "this letter is ostensibly in reply to that of Mr. Alexander Watt." For the purpose of clearing up any doubt which you may have in your mind on the subject, I may say that it *is* intended as a reply to Mr. Watt. It may appear to your readers that the only ostentation in connection with this subject is your pretended misunderstanding.

You say that you "leave the controversy between Mr. Elmore and Mr. Watt to Mr. Elmore and Mr. Watt."

I think it will not be apparent to your readers how you can logically take up this position in regard to the zinc dispute, after having adopted so totally different a course of procedure in regard to the copper companies. The following may prove to be a good reason:—It was pretty generally known that the officials of the Elmore copper companies were not allowed to answer the attacks appearing in the Press in regard to these companies. You may, therefore, have felt pretty safe in saying what you have said—adopting and backing Mr. Watt's absurd statements in regard to the copper companies, assuming that no reply would come. But as soon as "no other authority intervenes to prevent Mr. Elmore opening his mouth so widely" the effect is most marvellous, and prompts you to take refuge in a few sarcastic remarks, and to refer me to your correspondent. Surely a most glorious climb-down after the hitherto quasi-defiant air assumed by you. "All hell shall quake for this," cried Ancient Pistol. "The beginning of the end," croaked the Electrical Review, referring to Elmore's Foreign and Colonial Company on page 151. It is needless to add, Hell does not yet quake, and the end is not yet come. These two events are likely to occur contemporaneously.

For the purpose of bringing the facts out of the mystery that you would prefer to involve them in, I have to say that the statements referred to by me as being absolutely false are those recent statements which *you* now say are *your* statements, and for which you say *you* are responsible. I repeat those statements are—where they are specific—absolutely false, and it would appear that in all probability I am in a better position to judge of their accuracy than you are.

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* For our reply we refer readers to p. 515.—Eds. Elec. Rev.

You disclaim the ability to provide eyes and ears for those who will not see nor hear. In the same way, I do not claim to perform miracles by providing brains for those bereft of reason, and memories for those who have none.

I am not aware of having said that the honour of journalism was safer in my keeping than in yours, but I frankly say that I would much rather that *all* the honour which attaches to such journalism as yours is in connection with "Elmores" be yours instead of mine.

Your statement as to it being unnecessary for the editor of a paper to satisfy himself of the truth of his correspondents' statements as to other people being brain pickers, is just what I would expect from a journalist who goes out of his way to suggest, as you have done, how you think a patent may be successfully pirated.

Of course, if your ideas of honour and fair fight prompt you to repeatedly kick a man when he is bound hand and foot, by all means proceed with your persistent endeavour to engage me in a correspondence which I have already told you I am forbidden to undertake. Such correspondence would doubtless be quite a profitable undertaking for you, as it helps to gratuitously fill your columns.

I have only to say this, that in the reply you ask Mr. Watt to make to my letter it is to be hoped he will confine himself—which you have not done—to the point at issue, viz., are the authorities quoted by me anticipations of his patent (which patent he alleges I have stolen from him), or are they not?

Your readers have now had Mr. Watt's accusation and my reply placed before them, and are doubtless capable of arriving at a decision; so with Oliver Wendell Holmes's statement before me that "Controversy equalises fools and wise men in the same way and the *fools* know it," I must decline to spend any more time on this subject; only adding in conclusion that my brother is preparing a paper on the Elmore copper process at the invitation of the leading scientific society in this country, and, in the event of his obtaining his directors' sanction to read the same, you will have an opportunity of repeating the statements you have made, in a place, and at a time where, and when they can be fully answered.

I am sorry that this correspondence has partaken of so acrimonious a nature; the responsibility for this does not rest with me. If one goes to Rome one must do as the Romans do. I went to the Review and answered them in their own language. One would only appear ridiculous by using Lord Chesterfield's language in Billingsgate.

A. S. Elmore.

Leeds, *April 21st*, 1891.

Although I do not consider holding a controversy with a person of Mr. A. S. Elmore's type the most exhilarating way of disposing of one's time, I will reply as briefly as possible to the heterogeneous hash, which, bearing that individual's signature, appeared in your last issue. This latest offset of the Elmore family tree has endeavoured, by a series of misleading extracts, to show that the publication of chemical or electro-chemical data—the results of mere laboratory experiments, for example—renders void any patents subsequently obtained, in which such data necessarily became involved in the practical applications of science to the arts. If Mr. A. S. Elmore's notions were the law of the land—which, happily, they are not—the functions of the patent office could very well be dispensed with so far as electrolytic processes are concerned. The mere fact that Mr. So-and-So has stated in his book, as the result of his own laboratory experience that "you can reduce zinc from its sulphate, or acetate solution by means of a voltaic current," would not, so far as I understand the patent law, prevent a man from obtaining a valid patent for using the same materials, provided that his specification clearly described a practical method of preparing and using such materials, with a definite and useful end in view, by which the public would derive benefit.

My attention is called to certain passages in divers books, but the information thus conveyed is somewhat stale to me, inasmuch as my acquaintance with most of the works referred to dates from the period of their first publication—an unfortunate period, it is true, since there were no Elmores then! I am next favoured with extracts from works of a more recent date than those referred to above, but these extracts—evidently introduced to mislead your readers—have no reference whatever to my patents. In the English translation of Dr. A. Classen's *Quantitative Chemical Analysis by Electrolysis*, says Mr. A. S. Elmore, at page 63, occurs the following:—"Parodi and Mascazzini determined zinc by electrolysis in a solution of sulphate, to which has been added *sodium acetate* and citric acid, to acid reaction." Now, the above experiment has no bearing upon either of my zinc patents, in which there is no mention whatever of *sodium acetate*. Again, he says, "The same author, on the same subject, says, 'Riche reduces zinc from a solution of the acetate *with excess of ammonium acetate*, obtained by supersaturating with ammonia and acidifying with acetic acid.'" This, again, has nothing whatever to connect it with either of my zinc patents, as I do not use any salt of ammonium, in excess, or otherwise; neither is there any mention of ammonia in my zinc patents. And yet these extracts are put before your readers as evidences of *prior publication*, as against my patents! Does this not show to what extremes a certain class of persons will go in endeavouring to escape from a not very creditable position?

Mr. Elmore knew perfectly well, when he stated in his patent that acetate of zinc could be used in his process, that he did so for the purpose of interfering with my own zinc patents, for he makes no mention in his zinc patent of any particular method of preparing an acetate of zinc electrolyte, or in what way the electrolyte should be regulated, so as to give perfectly practical results. The mere mention of the zinc acetate as a salt that "may be used," is not such information as would enable an ordinary workman to adopt his process with acetate of zinc as the electrolyte.

An attempt is next made to show how my second patent has been anticipated, and this is how it is done: "Classen, page 63, uses a mixed electrolyte containing sulphuric and citric acids." By a perversity of fortune, however, the wiseacre is again at fault with his quotations, for it so happens that in my second patent citric acid has no place! I am further treated to a few passages taken from another book, but as I do not hold a very exalted opinion of the authority from whence these extracts are derived, I will pass on to some other portions of Mr. A. S. Elmore's letter which require a little attention. In reference to my being a consulting chemist, Mr. A. S. Elmore says "it would be really interesting to know what his clients consult him about." Would it? We'll see. Does he not remember the remarkable case of "Elmore *v.* Pirrie and others," in which his father, Mr. W. Elmore, sought to recover £15,000 damages for breach of contract—but didn't? Does he not remember a remarkable statement, published in my book "Electro-deposition," about the tensile strength of Elmore's copper tubes, in which the breaking strain was put down as equal to 32 tons per square inch of original area, with an elongation of 38·3 per cent? Does he not know who gave me that false statement for publication in my work? Does he not know that I furnished my clients in that case (the defendants) through their counsel, Mr. Moulton, Q.C., a slip of paper on which was written the false statement referred to? And surely he cannot have forgotten the severe remarks of the learned judge who tried the case—Mr. Justice Kay—in reference thereto? If so, the following will refresh his memory, and, at the same time, perhaps, convince him that in consulting me in this case, my clients had no cause for regret. In delivering his judgment in the case of Elmore *v.* Pirrie, Mr. Justice Kay, referring to the foregoing statement, said: "So that Mr. Elmore gave to Mr. Watt, and allowed to be published in the book, of which his son has a copy in court, this false statement about the breaking strain of copper tubes manufactured by him, and if he would do that, and if he had not the honesty to write to Mr. Watt and say that he had made a mistake, and ask him to correct it, how can I doubt that he would tell the same falsehood to the persons who were engaged in this negotiation with him."

Possibly the above may be sufficiently "really interesting," so far as regards what some of my clients "consult me about." However, I can oblige Mr. A. S. Elmore with some further information upon this point which may, or may not, "really" interest him, as he must have been busily engaged in cutting his "back teeth" about the time the incident referred to below occurred. It was in December, 1877, I think, that Mr. Van Winkle, of the firm of Coudit, Hanson and Van Winkle, Newark, N.J., accompanied by Mr. W. Elmore, arrived in this country, the former gentleman bringing with him a number of Weston's dynamo-electric machines. Having obtained my address, a meeting took place, at which Mr. Van Winkle expressed a desire that I should use my influence to get one of the Weston dynamos put down for trial at some plating works. About this I had but little difficulty—only a trifling amount of prejudice to overcome—and obtained permission of the late chairman for one of the machines to be fixed at the works of the Plating Company in Kirby Street. The machine gave unqualified satisfaction, was accepted and promptly paid for by the company; and, having closely watched its performances, at Mr. Van Winkle's request I gave him a report thereon, which was immediately printed in his circulars, which were sent broadcast through the country, and the Westons were freely adopted thereafter by many large firms in London and the provinces.

After a while, Mr. Van Winkle returned to America, leaving Mr. W. Elmore as his agent, and some time after that "improved Weston's" made their appearance, at which period, or soon after, the agency was brought to a rather abrupt termination, I believe. It was the prompt way in which I got the first Weston put down that led to its success, and it was the direct means of giving Mr. Elmore a footing in the London market. With the Weston machine came a goodly supply of "nickel salts," and these, in their turn, soon found their way into London and provincial workshops, and the number of nickel platers increased ten-fold in a very short time. Next came the suit of The Plating Company *v.* Farquharson. This company, the owners of Dr. Adams's nickel-plating patents, unfortunately believed that they had a complete monopoly of the right to nickel plate in this country. Well, the first trial took place, and the plaintiff company won the day. The London nickel platers—and especially Mr. Elmore, who had supplied the whole of them not only with Weston dynamos, but complete and costly "outfits," were in a state of fever at the result. Seeing the prospect of a large number of workshops being closed and their owners ruined by the decision in favour of Adams's patent—which nobody infringed—I, unprompted by any one, went direct from the Court, on the occasion referred to, to Clerkenwell, and laid the foundation for a defence fund, obtaining on the spot guarantees from leading firms of adequate support, which formed the nucleus of a still larger fund subsequently obtained. These events resulted in the case going to the Court of Appeal, in which, this time, the defendant was successful, and on further appeal to the House of Lords this latter decision was sustained, and all the nickel platers in London, Birmingham, Coventry and Sheffield were jubilant. Elmore, especially, was benefitted by this result, but the way in which he showed his gratitude was rather peculiar. Having started a large number of people in the nickel-plating business, for which he received considerable sums of money, he next started on his own account, and so reduced the prices as to seriously cripple the whole of the London trade, from which it has never since recovered, and never can.

With respect to the Elmore failures in the electro-deposition of zinc, in various parts of Wales, to which I referred in my former letter, Mr. A. S. Elmore, with the good taste you would expect from him, has been pleased to give me what he calls the "lie direct." Now let us see how readily this word rebounds from myself and seeks its natural resting place on the more genial soil of an Elmore! Full well he knew what I referred to, and whom I referred to, in my allusion to the costly attempts and failures which had been made in Wales to deposit zinc from a sulphate solution. Does he not know, whether he participated in one, or all, of the operations, that I was stating nothing but the truth when I referred to the Elmore failures in that part of the kingdom? Does he not remember anything about the trials with bluestone ore, &c.? It so happens that I have pretty good proofs of the grotesque attempts to which I referred, and I may say that the communications in which they were made known to me were couched in language which was not intended to be highly complimentary to the Elmore reputation! Possibly Mr. A. S. Elmore would not care to put my assertion to the test of proof? I am somewhat fearful that the copious store of "Elmore shares" which A. S. of that name professes to have "stuck to" with such Elmorian courage, must have had the effect of convincing him that, after all, he may be a person of some consequence. I should be sorry to disturb such a happy state of self-approval, but perhaps I may gently hint that I think it not improbable that a good many holders of similar shares—of any denomination—would not deeply grieve if Mr. A. S. Elmore and the rest of his illustrious family were the sole possessors of them.

As I have neither time nor inclination to enter into further controversy with Mr. A. S. Elmore, I should advise him to utilise his leisure moments in trying to overcome the "difficulties" referred to by Sir T. Farrer at the meeting of the holders of priority, &c., shares at Cannon Street Hotel the other day. A little less writing and a little more attention to foliated copper tubes would appear to be the best use for A. S. Elmore's spare moments.

Alexander Watt.

April 18th, 1891.

Inductive Disturbances in Telephone Circuits.

A perusal of the article in your issue of April 10th suggests that Mr. J. J. Carty is pursuing with commendable assiduity, at a distance of some 10 years, a path already, to no inconsiderable extent, explored by English telephonists.

In his fig. 11 Mr. Carty sketches a plan, from which he evidently expects important results, for reducing in a single wire the disturbing influences of neighbouring conductors. The same plan is described, figured and claimed in my patent, No. 4,428, of 1881. It has never been of much use practically, because the dividing and earthing of the wire at its centre prevented the necessary call signals being transmitted without the intervention of special apparatus. This objection has recently been overcome, but the plan can scarcely be made as efficient and simple as a metallic circuit.

Shunts, both of low and high impedence, on the plan illustrated in Mr. Carty's fig. 10, but applied to single wires (their use with a metallic circuit is unnecessary, since that should in itself be sufficient to suppress all disturbances), I employed as long ago as 1885. On the single trunk lines between Falkirk-Stirling, Stirling-Dunfermline, and Dunfermline-Kirkcaldy, telegraphic induction was greatly reduced by their aid without spoiling the speaking. But lines so fitted are liable to be stopped by faults that would not fatally affect an unshunted wire.

Mr. Carty's assumption that the important part played by static induction in telephonic disturbances has been hitherto overlooked surprises me, for I was under the impression that it had been recognised years ago. Personally I had satisfied myself on the point by direct experiment. In practice, however, all problems in connection with metallic circuits can be solved by assuming the presence of current induction only, a fact which may account for the little prominence given to static induction in published discussions.

A. R. Bennett.

April 20th, 1891.

Lundy Cable Company, Limited.

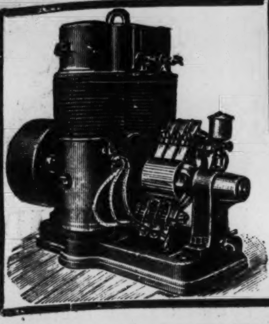
Some time ago the liquidator of this company offered the cable for sale, and I purchased the same. I have just returned from picking it up. I found the cable in perfect condition, except in one or two places where it had been chafed by the rocks, and I also found a break caused probably by some wreck having driven over it, the cable on both sides being in absolutely perfect condition.

From personal observation and local information that I gathered while engaged in the operation, I am convinced that if the cable be relaid to the Devonshire coast at Braunton, there would be no further trouble in maintaining it, as it would be lying upon sand for the whole distance.

G. F. Rogers.

April 21st, 1891.

[We should be pleased to learn that steps had been taken to adopt the suggestion made by our correspondent. The value of such a means of communication between Lundy Island and the mainland, from the humanitarian point of view at least, can scarcely be over-estimated.—EDS. ELEC. REV.]



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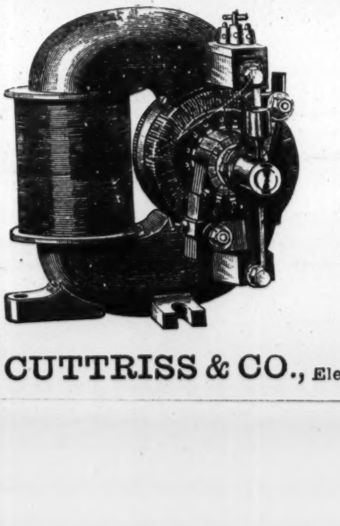

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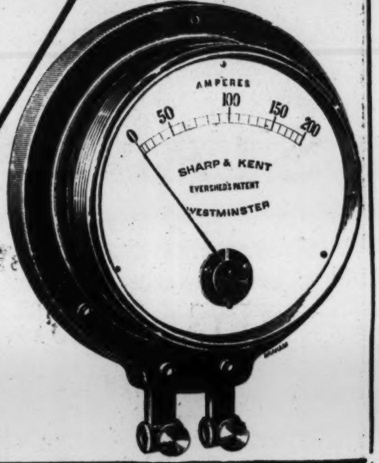

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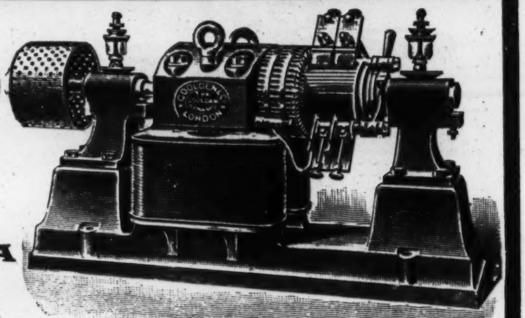

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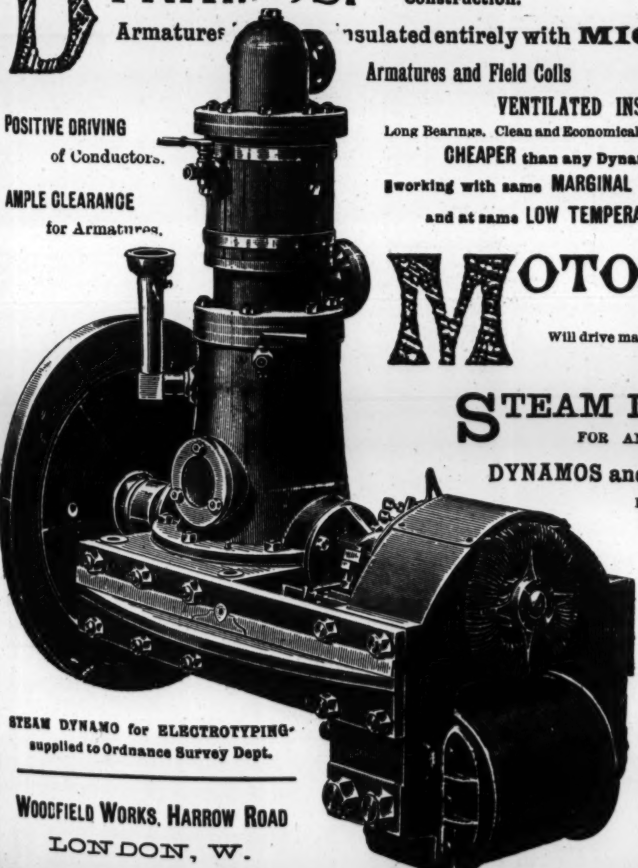

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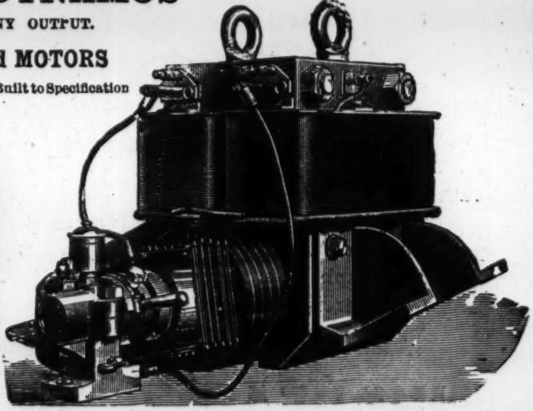

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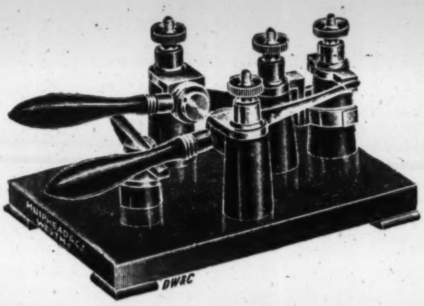

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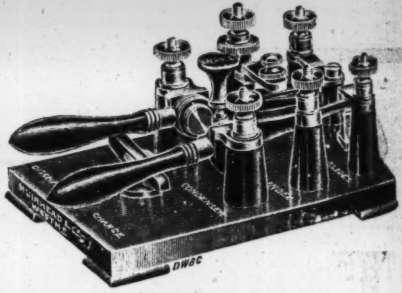

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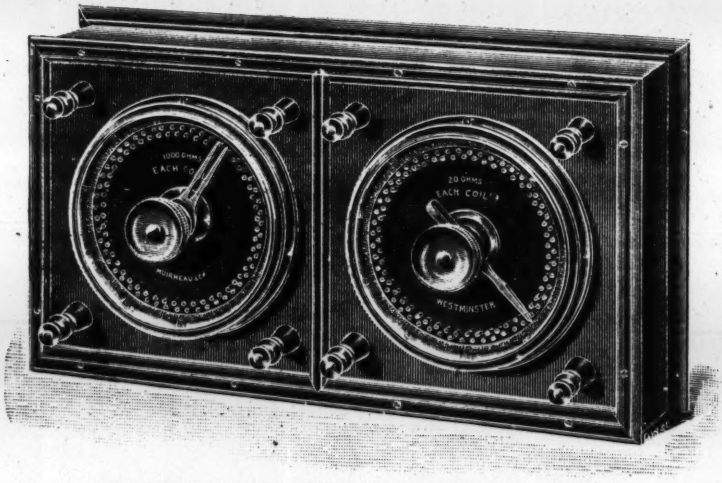

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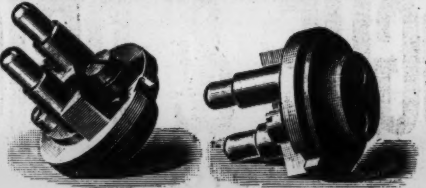

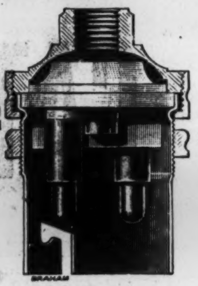

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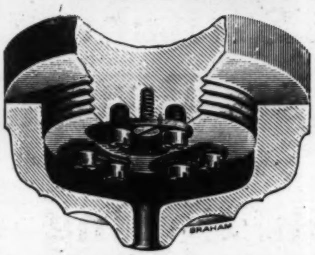

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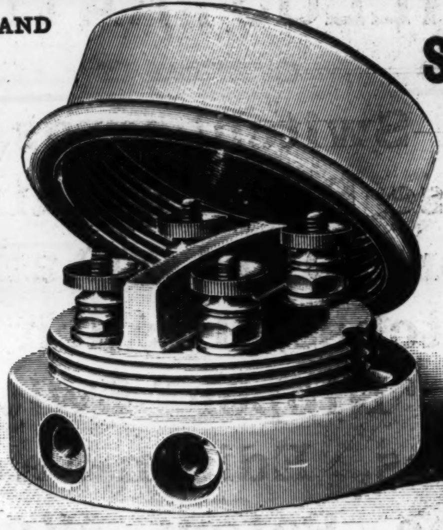

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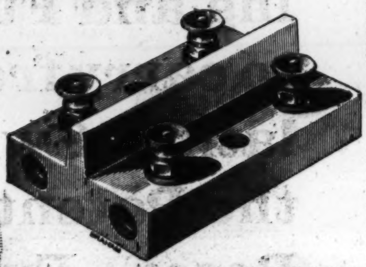

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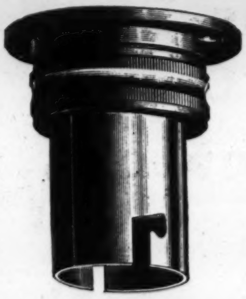

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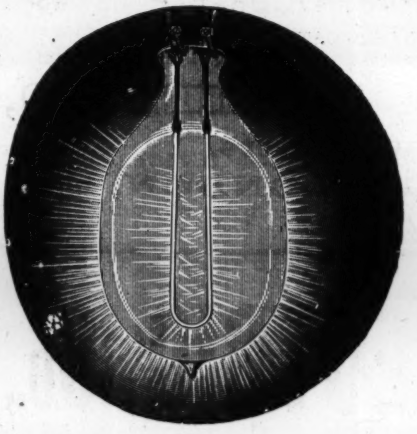

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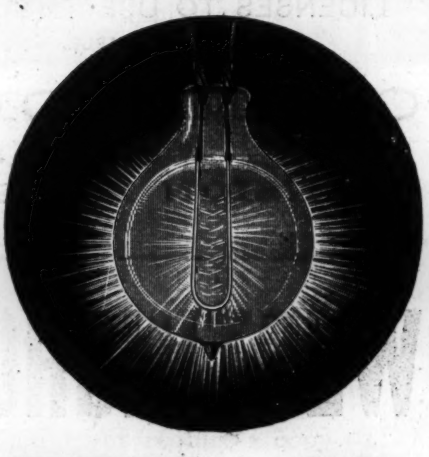

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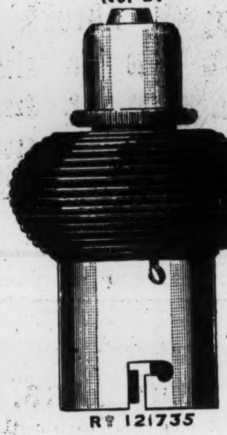

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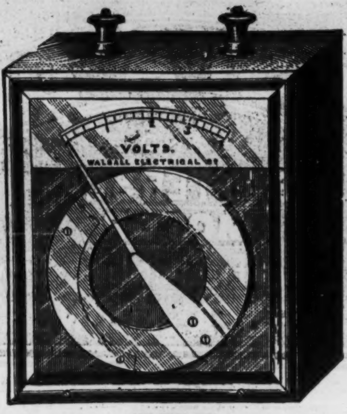

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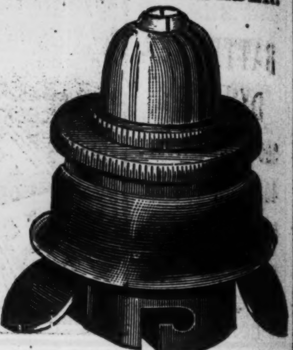

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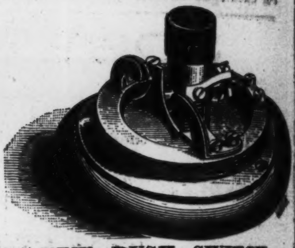

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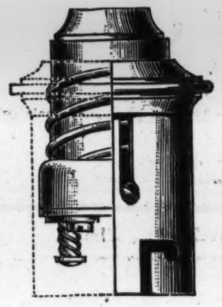

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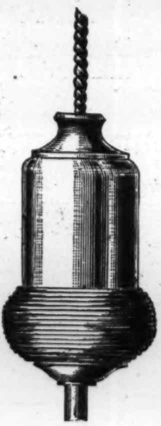

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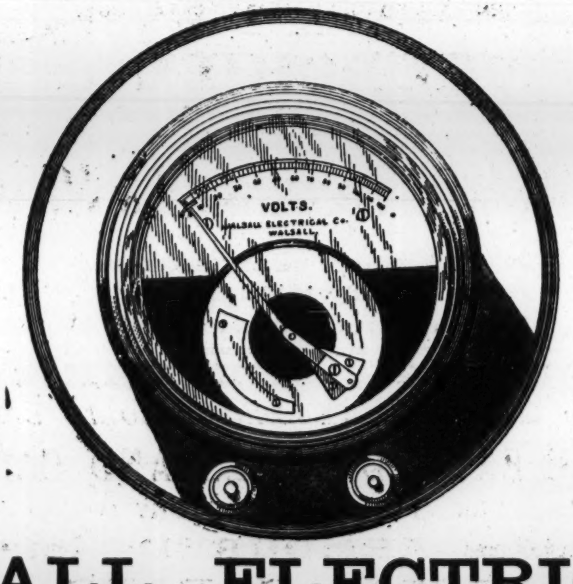

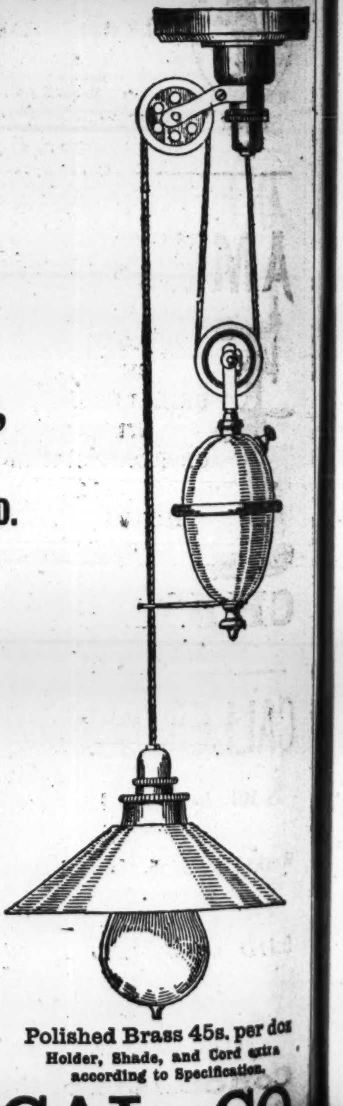

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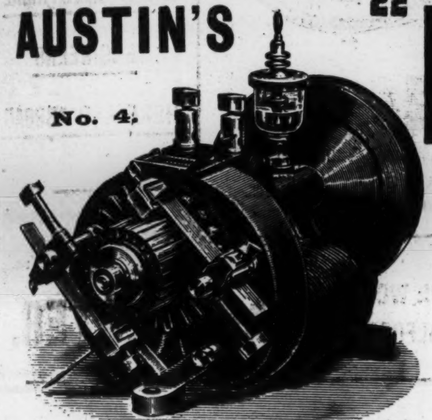

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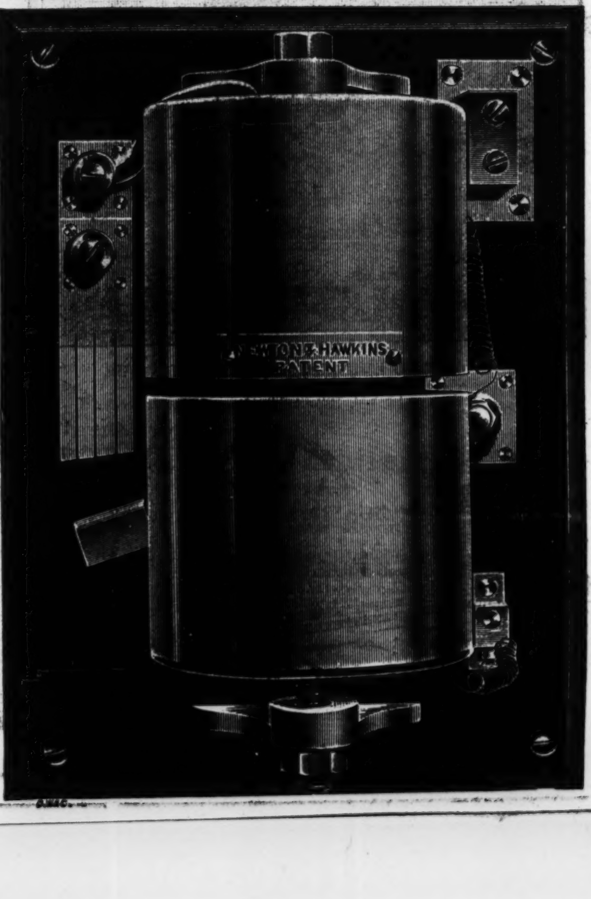

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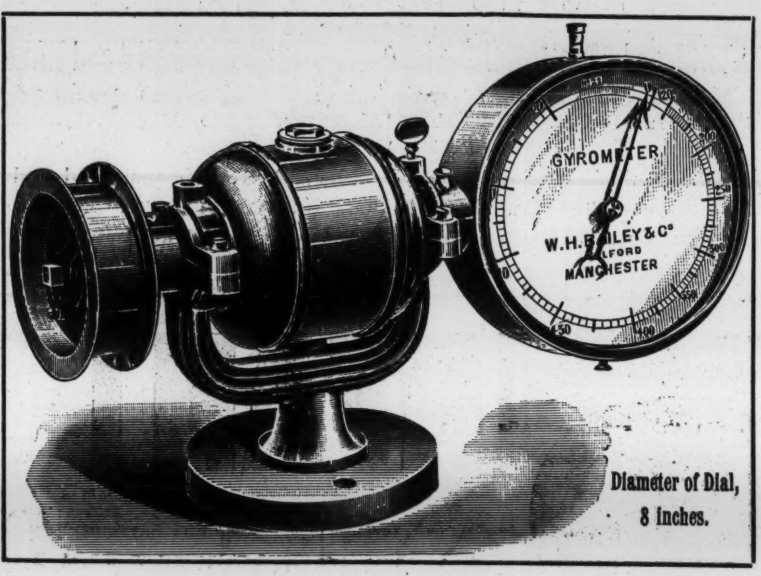

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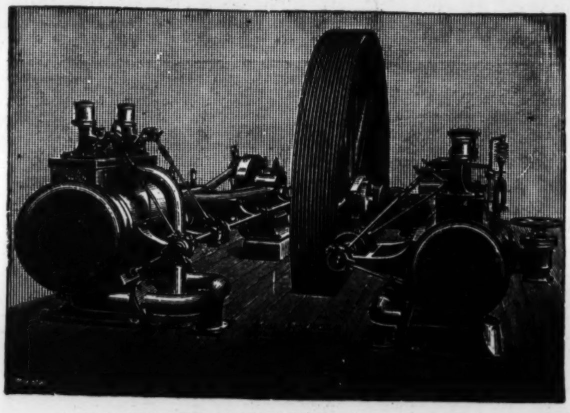

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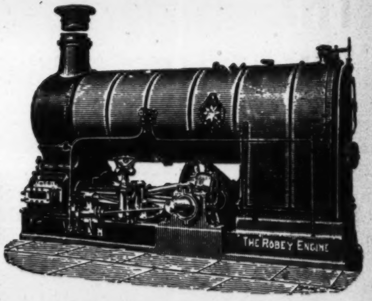

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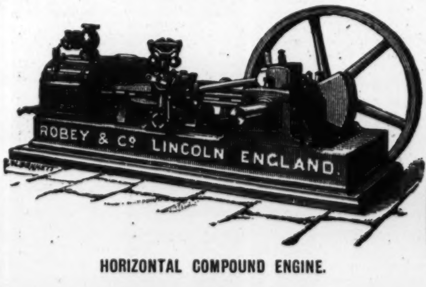
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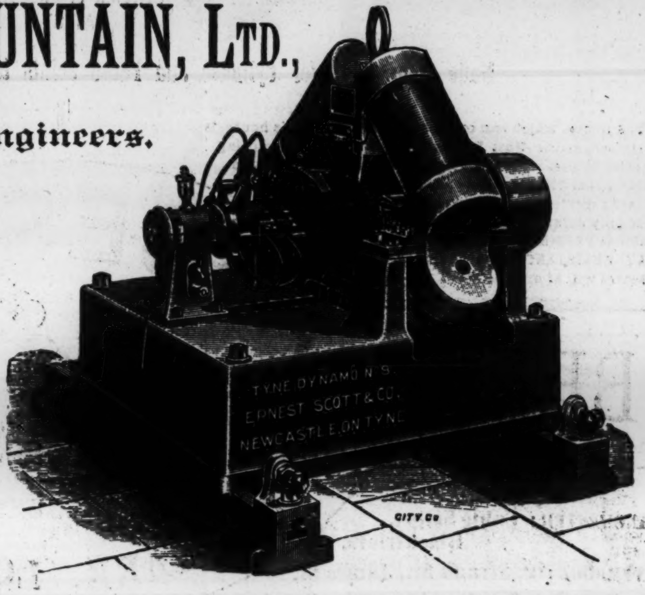

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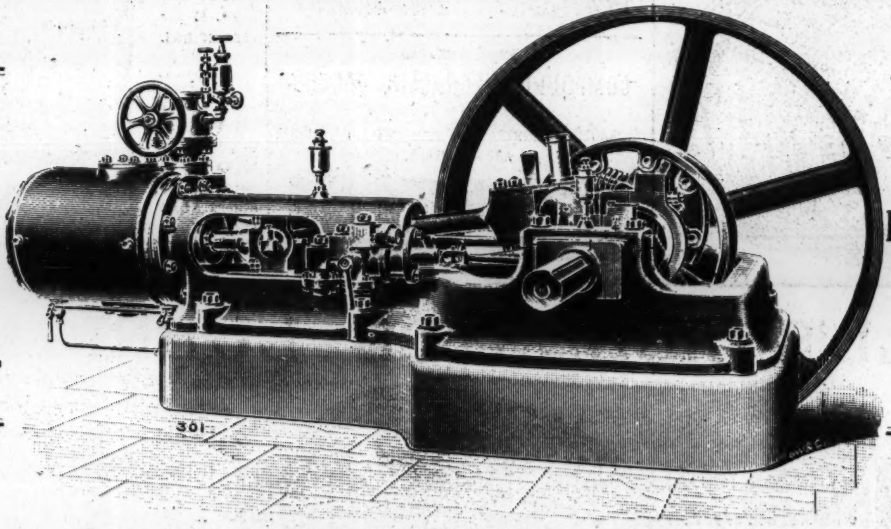

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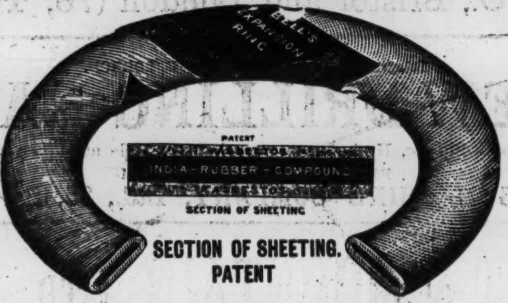

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Made from 1-Ply for Cylinder and Faced Joints to any thickness for uneven surfaces.

The above, which can only be obtained from this house, is recognised as the Most Efficient and Economical Jointing Material in use. It is composed of a specially-prepared India-rubber Compound, protected by a covering of Vulcanised Asbestos Sheeting, as shown above, and as it is the only Jointing Material which adequately combines PERMANENT ELASTICITY WITH HEAT RESISTANCE, the advantages it possesses will at once be seen.

The Centre from which the requisite elasticity is obtained will adapt itself to uneven surfaces to which it may be applied, and allow the expansion and contraction to be fully taken up. The covering being of Asbestos Cloth, imparts a protection to the centre and so prolongs its elasticity. For Manhole, Mudhole, Steam Pipe, and Mash Tun Door Joints it is unequalled, and if applied as directed a ring can be used many times over.

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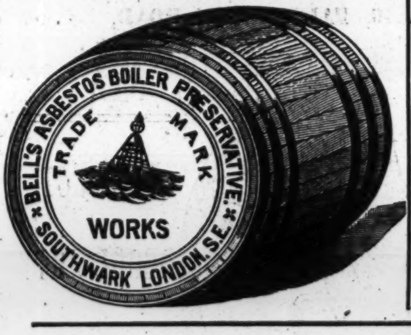

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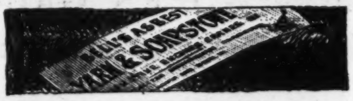

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All bags are marked as above.

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Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as

shown, is earnestly requested to forward us sample and particulars of where obtained.

ASBESTOS BELL'S LUBRICANT

Drums are marked as above.

Every Cask is sent out as above.

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BELL'S ASBESTOLINE.

REGISTERED.

All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A, is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C, is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

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DAGGER PACKING.

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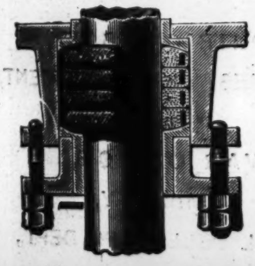

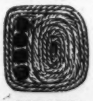

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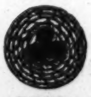

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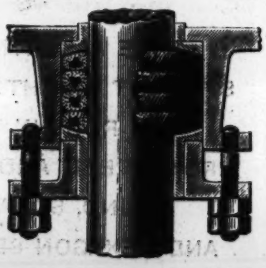

Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

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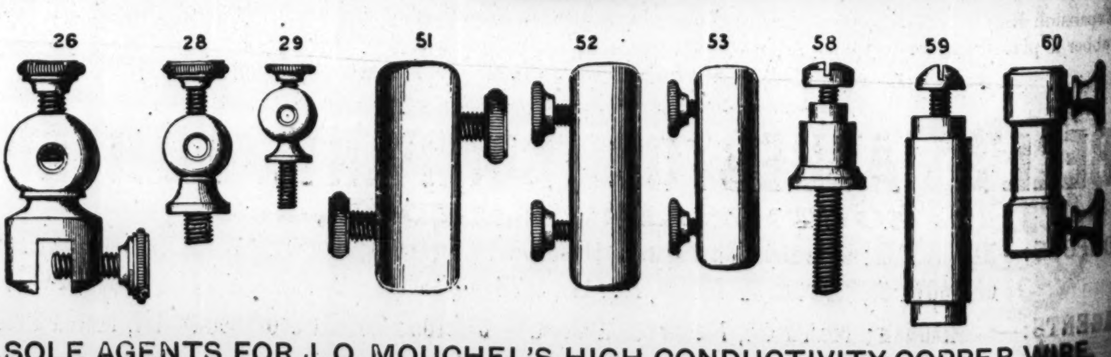

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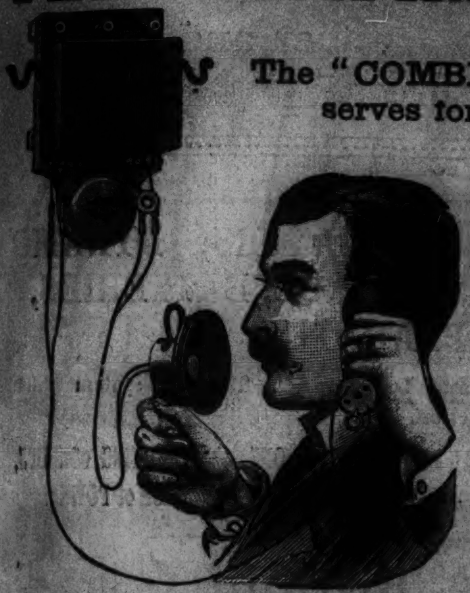

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